# MACHINERY

*Design—Construction—Operation*

Volume 43 | APRIL, 1937 | Number 8

Are modern apprentice systems successful? In May MACHINERY, the Caterpillar Tractor Co. answers this question by an emphatic "Yes." For many years, this company has operated very extensive and highly developed training courses with outstanding success. Every man engaged in industry who has been faced with the problem of shortage of skilled mechanical men will find in this article the answers to many questions that he has asked.

## PRINCIPAL ARTICLES IN THIS NUMBER

FOR COMPLETE CLASSIFIED CONTENTS, SEE PAGE 572-N



## DEPARTMENTS



PUBLISHED MONTHLY BY
THE INDUSTRIAL PRESS
148 Lafayette Street New York

ROBERT B. LUCHARS........*President*
EDGAR A. BECKER..*Vice-pres. and Treasurer*
ERIK OBERG........*Editor*
FRANKLIN D. JONES......*Associate Editor*
CHARLES O. HERB.......*Associate Editor*
FREEMAN C. DUSTON ....*Associate Editor*

LONDON: 52-54 High Holborn
PARIS: 15 Rue Bleue

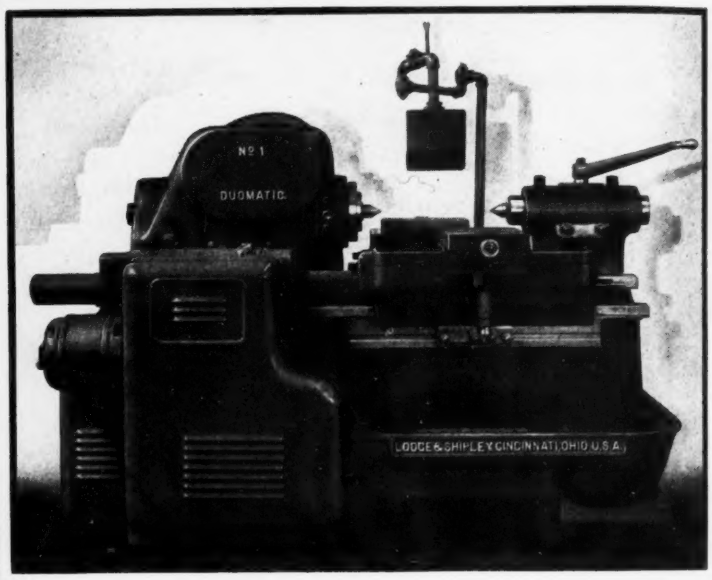
YEARLY SUBSCRIPTION: United States and Canada, $3 (two years, $5); foreign countries, $6. Single copies, 35 cents.
Changes in address must be received by the fifteenth of the month to be effective for the forthcoming issue.
Send old as well as new address.

Copyright 1937 by The Industrial Press.
Entered as second-class mail matter, September, 1894, at the Post Office, New York, N. Y., under the Act of March 3, 1879. Printed in the United States of America. Member of A.B.P. Member of A.B.C.

CIRCULATION 15,699

# DUOMATICS . . . MODERN

THE
NO. 1 DUOMATIC
LATHE




**Designed for high speed quantity production in the lighter fields of automatic lathe work, the Lodge & Shipley No. 1 Duomatic lathe has earned a well deserved reception wherever speed and accuracy influence profits. Simple in set-up and operation the No. 1 Duomatic is a production tool worthy of your consideration.**

## LATHES *Good* LATHES ONLY

# MACHINERY

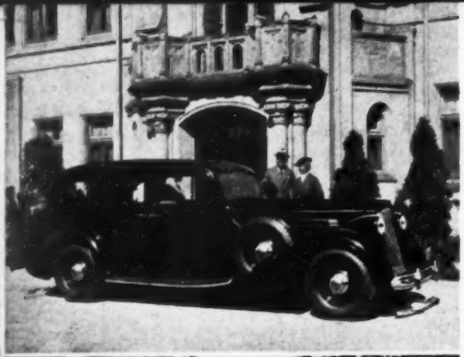
Volume 43 NEW YORK, APRIL, 1937 Number 8

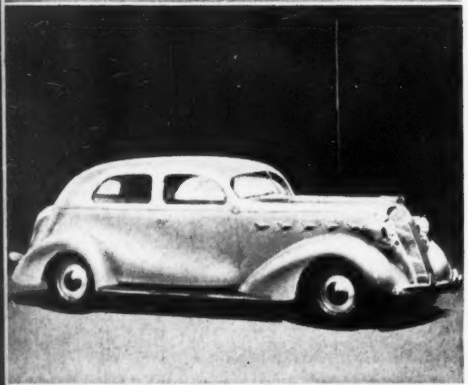
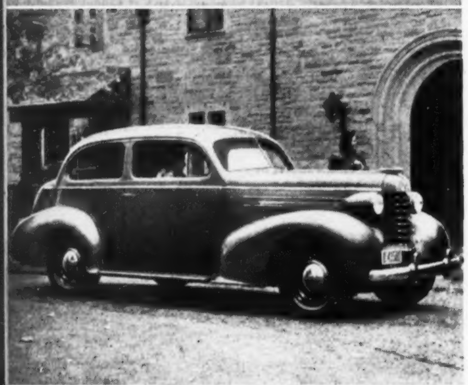
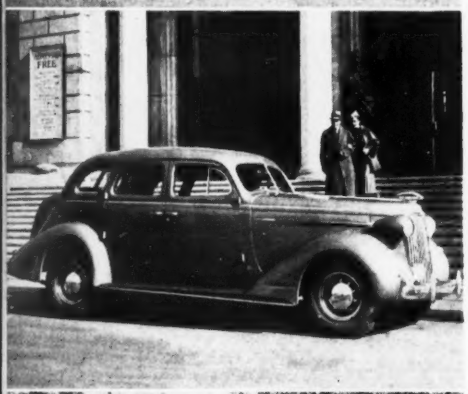
# *The Automobile and the Machine Tool Industries*

*By Alvan Macauley*

***President, Automobile Manufacturers Association***
***President, Packard Motor Car Co.***

THE machine tool industry, as well as other mechanical industries, should be, and unquestionably is, keenly aware of the important influence on other business that is wielded by the automobile industry. The machinery manufacturers have benefited greatly through the millions of dollars expended by automobile manufacturers for plant equipment throughout the entire history of the industry, and especially within the last two or three years. Indirect, but none the less important, have been




# *THE AUTOMOBILE INDUSTRY AND*

the effects of the expansion in the automobile industry as they have extended to many other industries which are, in turn, large users of machinery.

THE automobile industry many times has proved itself a leader when there was a crying need for leadership for the restoration of more prosperous conditions. This leadership has never been more in evidence than during the last three years. The courage to spend large sums of money for new equipment which would aid in vastly improving the automobile industry's product was one of its most effective weapons in carrying on the battle that it so successfully waged against the business depression.

CERTAINLY no small part was played in this battle by the machine tool industry. Machines that would do better work, more quickly and at less cost, had to be available in order for the automobile industry to carry out its great program. When the automobile manufacturers launched forth in their planning, they found in the machine tool industry courage aplenty, long-headed thinking, and complete faith in the future of business—they found the required machinery of new and revolutionary design ready at hand.

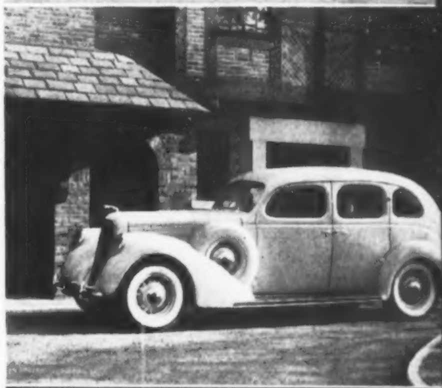
AUTOMOBILE manufacturers produced cars of so much greater value and attractiveness than ever before that the public felt it just had to have them. People wanted these new, finer automobiles more than they did their dollars. That started the constantly accelerated buying that quickly launched the automobile industry into its position of now world-acclaimed leadership.

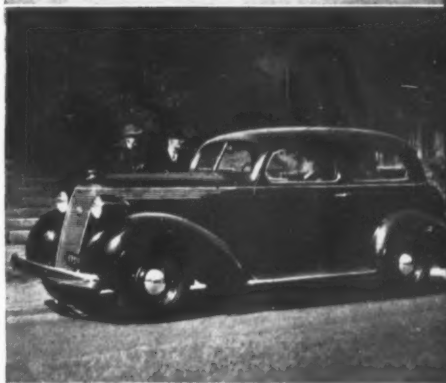
IN effect, that is just what the machine tool industry also did. During a time when its markets were practically closed, both here and abroad, manufacturers in that industry were intensively at work, just as were the automobile manufacturers. They produced new machines that the makers of motor cars had to have. The automobile industry could afford to do nothing else but buy.

THERE is no question but that restoration of volume motor car production quickly spread business throughout the country. The iron and steel industry and the railroads, to name but two of many, were helped greatly. They, in turn, used a big part of their increased earnings for the purchase of new and much needed equipment, and this spread business still further.

THE dollars of commerce in this country seem to be traveling now in their old familiar paths. There apparently is a good feeling generally throughout the country about the business prospects in 1937. We in the automobile industry quite naturally are pleased because we have been given much credit for the part we had in the revival of industry. We believe much credit is also due to the machine tool industry, and we are happy to have the opportunity of saying so.

Alvan Macauley





# *Chevrolet Uses Latest Machines*

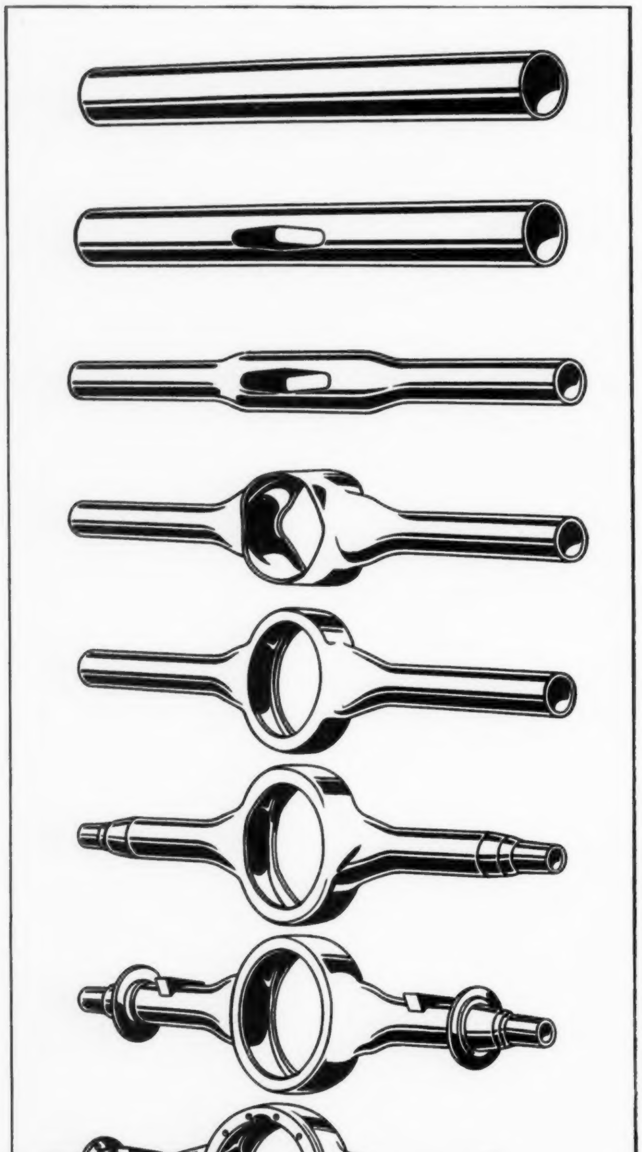


*Fig. 1. Successive Steps in Forming Chevrolet Rear-axle Housings from One Piece of Seamless Steel Tubing. Two Slots are First Pierced through the Center of the Tube, Then the Ends are Swaged, and Central Part is Expanded to Form the "Banjo"; Next the Brake Support Flanges are Welded to Housing*

*The Rear-Axle Housing of 1 1/2-Ton Trucks is Produced from a Single Piece of Seamless Steel Tubing. High-Production Machine Tools of Latest Design are Used for Finishing the Housings*

*By CHARLES O. HERB*

YEARS of engineering study and development are reflected in the rear-axle housing now provided on Chevrolet 1 1/2-ton trucks. This housing is made from a single piece of high-grade seamless steel tubing by a series of operations which are performed in the succession indicated in Fig. 1. At the beginning of the process the seamless steel tube is 5 3/4 inches outside diameter and has a wall thickness of 0.325 inch. Two slots are pierced through the wall in the center of the piece in a preliminary operation, after which the tube is swaged to a diameter of 3 1/2 inches from both ends to the center portion in the vicinity of the slotted holes.

The center portion of the tube is next spread out to shape the "banjo" approximately, and then the banjo is formed to the desired contour and flattened on the sides to provide narrow flanges. The ends of the rear-axle housing, as the part can now be called, are next swaged to an outside diameter of 2 13/16 inches and a wall thickness of 9/16 inch. Narrow rings are now welded to the faces of the banjo for reinforcement purposes, and brake support flanges are welded near the outer ends of the housing. Then the ends are turned and rough-drilled, after which the housing is sand-blasted all over. In this condition, the housings reach the Chevrolet Gear & Axle Plant, Detroit, Mich., for the machining operations.

Rear-axle housings produced in the manner outlined have superseded a design that consisted of a malleable-iron differential carrier and steel tubes which were pressed into the carrier and riveted to it. The new one-piece housing is lighter in weight, considerably stronger, and can be heat-treated to avoid breaks or fractures at localized points.

# on Seamless Rear-Axle Housings

The first operation at the Gear & Axle Plant consists of checking the rear-axle housing for straightness and making any corrections necessary. This work is performed on the 75-ton hydraulic press illustrated in Fig. 2. The housing is supported in V-blocks at the ends, and a gage in the center of the machine table determines whether the banjo sides are parallel with the axis of the housing and at the proper height in relation to the axis. The gage consists of a slide which is operated by hand on an incline. When the top surface of the gage is against the banjo face, a scribed line on the slide must register between two graduations on the fixture base. Approximately sixty housings can be checked and corrected per hour.

In handling housings in this and subsequent operations, use is made of overhead balancers equipped with spring hoists of 90 pounds capacity. These balancers enable one man to load and unload housings weighing as much as 100 pounds at the various machines. Without the balancers, two men would be required for loading and for unloading.

The first machining operation consists of using combination boring and facing tools to simultaneously center both ends of the housing and face them to length with respect to the center of the banjo. For this operation, the housing ends are supported in V-blocks and the housing is located endwise from the banjo, as illustrated in Fig. 3. This operation is performed at this time in order that the rear-axle housing can be held by means of a hydraulic centralizer in the two succeeding operations, which consist of taking large numbers of cuts simultaneously in automatic lathes. Should the distance from the center of the banjo to one end of a housing be longer than to the other end, the housing would be deflected in those operations.

One end of an automatic lathe employed for simultaneously rough turn-

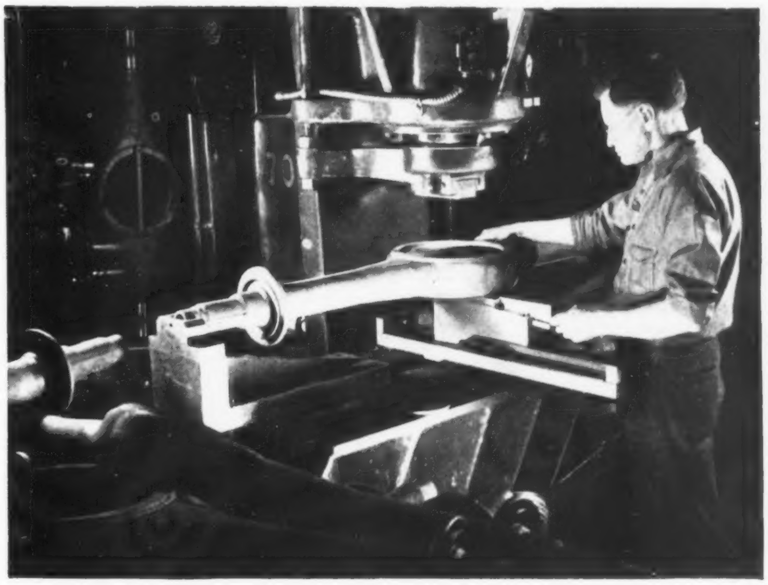


*Fig. 2. Each Rear-axle Housing is Carefully Checked for Straightness, and Necessary Corrections are Made by a 75-ton Hydraulic Press*

*Fig. 3. A Preliminary Operation in Machining the One-piece Rear-axle Housing is to Center the Ends and Face Them to Length*

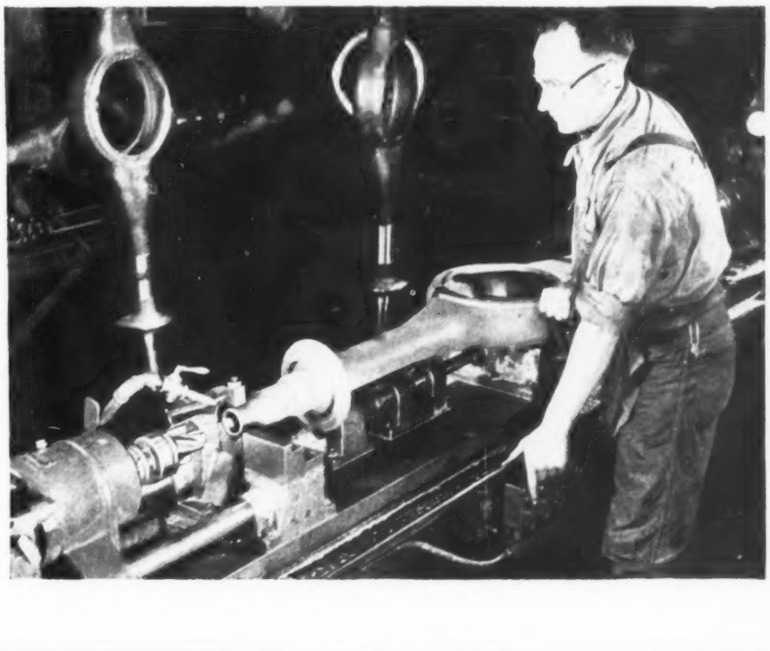




*Fig. 4. Thirty-two Rough Turning and Facing Cuts are Taken Simultaneously on the Rear-axle Housing Ends by Automatic Lathes. These Surfaces are Finished in Similar Machines*

ing and facing all the surfaces at each end of the rear-axle housings, including the brake flanges, is shown in Fig. 4. There are thirty-two cutters on this machine, sixteen at each end. The average depth of cut is 1/16 inch, and tools of Super high-speed steel are used. On this operation, a production rate of eleven housings an hour is maintained, including time out for changing tools, etc.

The housing is held in this machine between centers, the headstock being fitted with a spring-loaded adjustable center, and the tailstock with a center attached to the end of an air-operated ram. The housing is rotated by the center drive attachment which engages the banjo portion. Adjustable clamping devices are employed to avoid springing or deflecting the housing. The tool carriage at the right-hand end of the bed travels from right to left in taking the cuts, while the carriage at the left-hand end travels from left to right. These carriages, of course, first feed to depth before starting their traverses. The facing tools at the rear simply rock forward to take their cuts.

Similar automatic lathes, equipped with heavy pot chucks, are used for taking finishing cuts on the same surfaces of the rear-axle housings. This type of chuck also supports and drives the housing at the banjo. It insures accuracy and the correction of any errors that may occur in the roughing operation. Each finishing machine is equipped with twenty-eight tools. Eleven housings are finished per hour. The average depth of cut is 1/32 inch. There are twelve automatic lathes of this type in the rear-axle housing line, six being used for roughing and six for finishing.

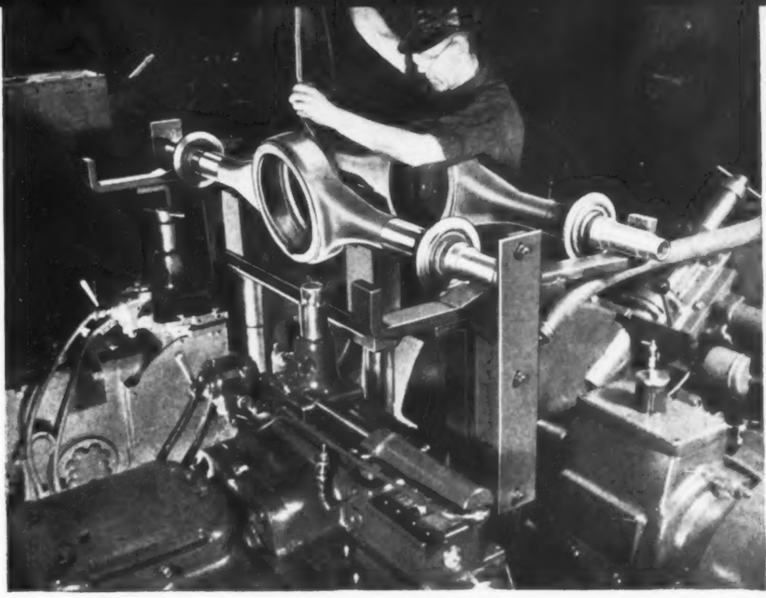
Huge centerless grinding machines are employed to grind cylindrical spring seats to a diameter of 3.441 to 3.444 inches for a length of 6 inches between the banjo and the two brake flanges. One of these machines is illustrated in Fig. 5. The grinding wheels are mounted on heads which rock forward against the work for the operation and recede when the operation is completed. The grinding wheels are 30 inches in diameter by 6 inches in width. Approximately 1/32 inch of stock on the diameter is ground off, the production averaging forty housings an hour per machine.

This machine is loaded by a hydraulic elevating device, seen in the raised position in Fig. 6. After a finished housing is lifted from this elevator by an overhead balancer, the next housing is rolled forward on the elevator. Then the elevator descends, lowering the housing on a steadyrest, which holds it in the correct relation to the feed and grinding wheels of the machine, as shown in Fig. 5. Two centerless grinders of this type are used.

After several minor operations, including the arc-welding of anchor plates and brake clips and a static balancing test, the rear-axle housings reach

*Fig. 5. Cylindrical Surfaces 6 Inches Long are Ground for Spring Seats in Huge Machines of the Centerless Type Equipped with Hydraulic Elevators for Loading and Unloading*

Fig. 6. The Hydraulic Loading and Unloading Device of a Spring-seat Centerless Grinding Machine is Shown Here in the Raised Position at the Completion of an Operation



centerless grinding machines of the type shown in Fig. 8, which simultaneously grind two bearings on one end to size within a tolerance of 0.001 inch. After the bearings at one end have been ground, the housing is turned end for end and similar surfaces are ground on the opposite end. These bearings are of different diameters, being 2.2488 to 2.2498 inches and 2.6238 to 2.6248 inches, respectively. Each surface is approximately 1 inch long, the distance between the two grinding wheels being about 3 1/2 inches.

In this operation, the housing ends rest on rollers and are backed up by the customary feed-wheels. The supporting rollers are so designed that they can be indexed from time to time, to compensate for wear. When the rollers have been worn completely around their periphery, they are replaced by new ones. This centerless grinding operation is performed at the rate of seventeen housings an hour, ground on both ends.

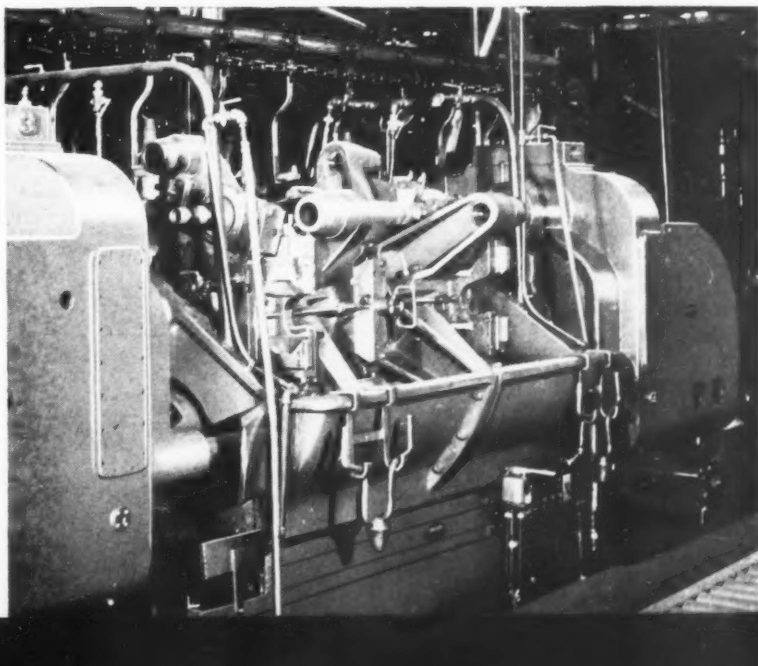
Similar centerless grinding machines finish oil-seal bearing surfaces at both ends of the housings. One of the two wheels of the machines used for this operation is dressed with a step for grinding to diameters of 3.188 to 3.190 inches and 3.196 to 3.198 inches. This operation is also performed first at one end of the housing and then at the other end. The hourly production is twenty housings.

Both sides of the banjo are faced in upright drilling machines equipped with a special drive at the right-hand side of the column for a large inserted-blade milling cutter, as illustrated in Fig. 9. This cutter automatically starts rotating as it is lowered to the work and stops the instant that the downward feeding movement is reversed. When one face of the banjo has been finished, the housing is turned 180 degrees on its axis and faced on the opposite side. Approximately thirteen housings are finished complete each hour.

The next operation is performed in a double-end multiple-spindle machine (Fig. 7), equipped with a rotary drum for indexing the rear-axle housings to five successive stations. This operation consists of drilling six holes through each brake flange, burnishing the oil-seal bearing surfaces at both ends of the housing by means of tools consisting of three rollers, threading the housing ends to receive wheel nuts, and milling a slot in each of the threaded ends. The work-holding fixture is indexed manually, but the tool-heads are fed hydraulically to and from the work. As these heads advance, pilot bars enter bushings on the drum, locking it securely to the heads while the cuts are being taken.

The threading of the housing ends is performed by die-heads equipped with circular chasers. The threading units are provided with individual motor drives, and remain stationary while the heads are fed to the work. The threading units feed them-

Fig. 7. A Multiple-spindle Machine of Double Head Construction Performs a Series of Drilling, Burnishing, Threading, and Milling Operations on Ends of Rear-axle Housings



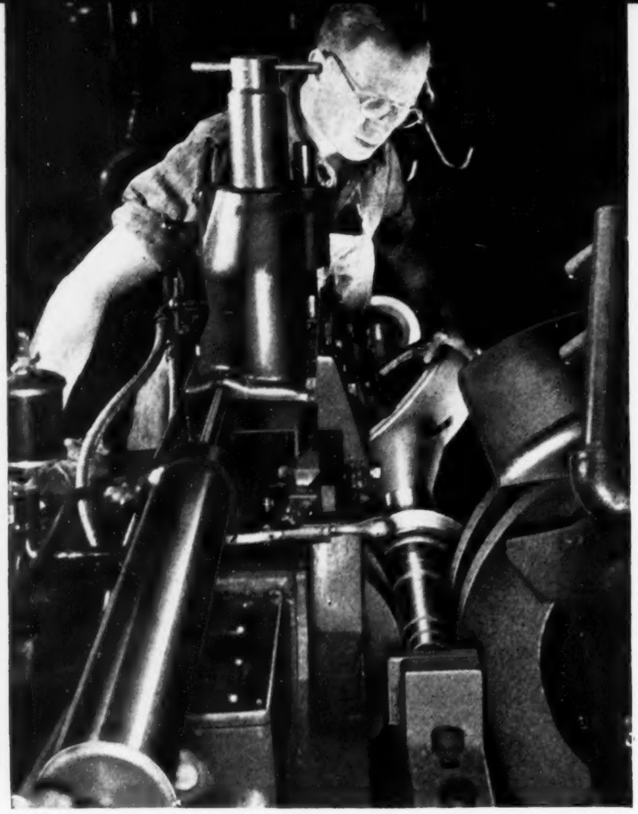


*Fig. 8. Centerless Grinding Machines Equipped with Two Wheels Simultaneously Finish Two Bearing Surfaces Near the Ends of the Rear-axle Housings*

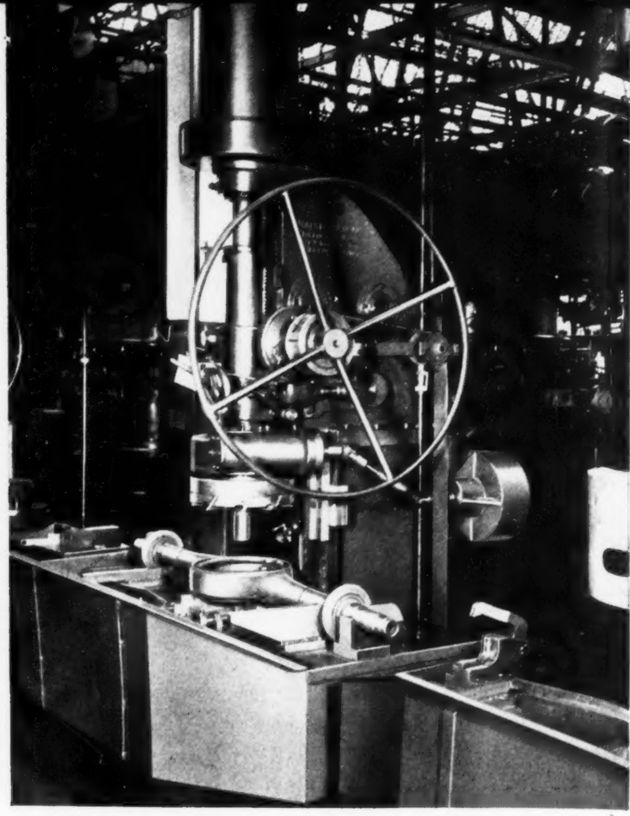


*Fig. 9. Each Face of the Banjo is Finished by a Face Milling Cutter, so Driven that it Revolves when Approaching the Work and Stops when Feed is Reversed*

selves on the work, so that they control the lead of the threads. Forty-eight housings are completed hourly in this operation.

Flats for clearance purposes are broached on one side of the two brake flanges simultaneously by means of the double-ram hydraulically operated machine shown in Fig. 10. Stock is removed to a maximum depth of about 1/2 inch, the operation being performed at the rate of seventy-two housings an hour. One of the features of this operation is that the table and fixture move lengthwise after a housing has been loaded, so as to bring the flanges into line with the broaches. This table movement, which is effected hydraulically, reduces the height to which the broaches must be raised in order to clear the rear-axle housing flanges when the work is loaded on the machine. A conveyor beneath the table automatically carries the chips to a receptacle at the left-hand end of the base.

Ten holes 29/64 inch in diameter are drilled simultaneously in each banjo face on a double-head multiple-spindle machine, and tapped in two operations on upright drilling machines.

At the end of the machining operations, the rear-axle housings are thoroughly cleaned by passing them through a conveyor type washing machine. They are then carefully inspected for dimensional accuracy prior to delivery to the assembly line. In this final inspection, all diameters and lengths are checked, as well as the squareness of the flange faces with the various other surfaces. The finished length of the housings is 73.396 to 73.416 inches.

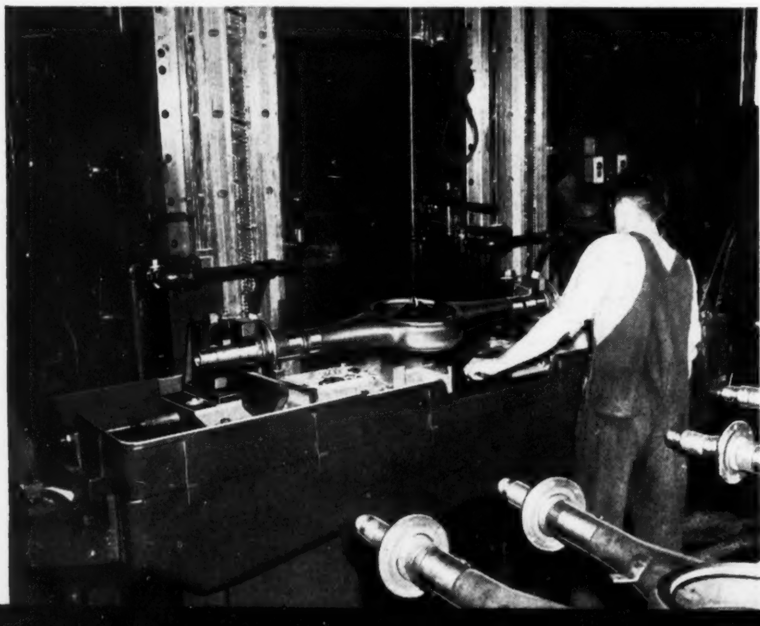
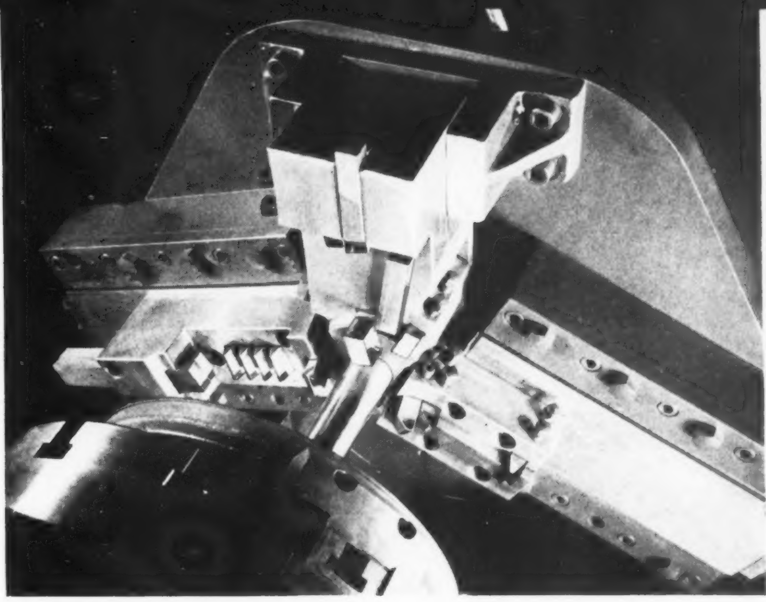


*Fig. 10. Flats for Clearance Purposes are Simultaneously Broached on One Side of Two Brake Flanges by a Heavy Double-ram Hydraulically Operated Machine*

Fig. 1. In the First Operation on Automobile Flywheels Performed on Gisholt Simplimatics, Fourteen Tools Mounted on Three Radial Slides Simultaneously Take Turning, Facing, Recessing, Forming and Chamfering Cuts



# *Eight Simplimatics Replace Twenty-Four*

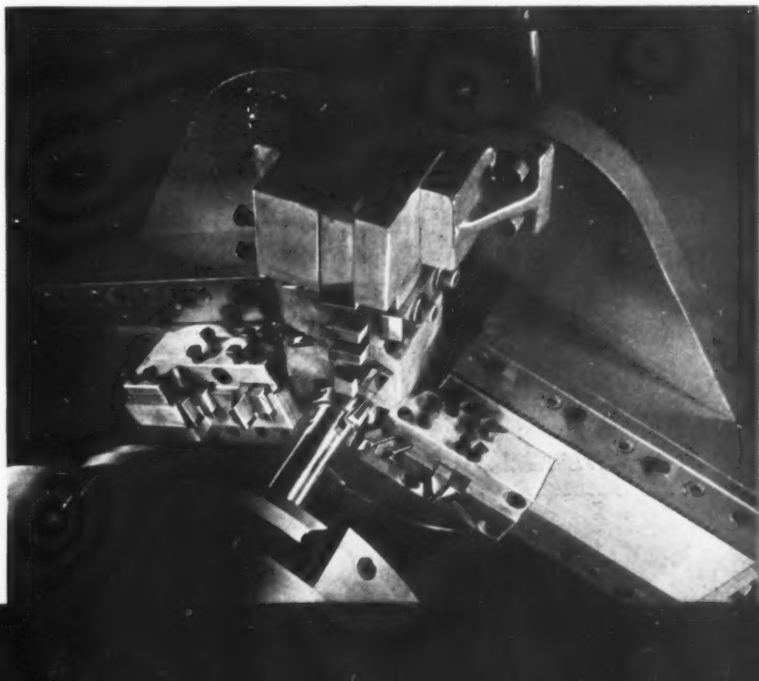
THE advantages gained by installing modern machine tools in place of older types are strikingly illustrated in the flywheel department of an automobile plant, where eight new radial type Simplimatics, built by the Gisholt Machine Co., Madison, Wis., are now producing as much as twenty-four old type Simplimatics. In addition to eliminating sixteen machines, two-thirds of the floor space formerly required has been made available for other use. Over 1000 flywheels are produced in 7 1/2 hours by the new machines in which one operation combines three former operations. The flywheels are machined complete on both sides in two operations.

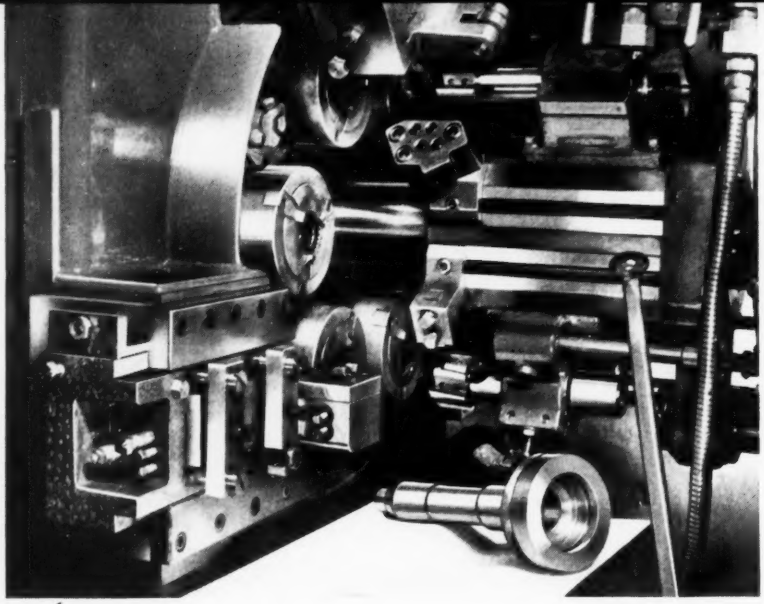
The tools are arranged radially with respect to the work, as seen in the accompanying illustrations, a construction that permits a maximum number of tools to operate simultaneously. The machines are equipped with a heavy carriage having a vertical face on which the tool-slides are mounted close to the work, with minimum overhang of the tools. Cams mounted on a drum control the movement of the tool-slides. The tooling includes a central boring and turning slide, which is fed longitudinally, and two radially positioned slides on which tools are mounted for facing, recessing, forming, and chamfering.

The cycle is entirely automatic after the operator moves a lever to start the machine. Then the carriage on which the tool-slides are mounted is traversed close to the work by air pressure, the spindle starts revolving, the tools feed to machine the work to the required dimensions, the tool-slides return to their starting positions on the carriage, the carriage quickly returns to its starting position, and the spindle stops, ready to be reloaded for the next cycle of operations.

The tools remove stock to a depth of approximately 3/32 inch in the various cuts. The cutting speed is 200 feet a minute, except in the final shaving cut, which is performed at a speed of 100 feet a minute. A feed of about 0.030 inch gives a long tool life between grinds. Fourteen tools are used in the first operation, which is illustrated in Fig. 1, and fifteen tools in the second operation, which is shown in Fig. 2.

Fig. 2. In the Second Operation on the Automobile Flywheels Fifteen Cutting Tools Arranged on Radial Slides Take Turning, Facing, Forming, Recessing and Chamfering Cuts





# Automatics for Unusual

*Operations that Typify the Versatility and Production Possibilities of Present-Day*

THE production possibilities of modern automatic screw machines have made obsolete manufacturing performance that was considered exceptional a comparatively few years ago. In the manufacture of studs and bolts of various types, automatics of today have effected production increases as high as 300 per cent over machines built as recently as 1928.

Not only are modern automatics faster, but they are also far more versatile, being capable of taking cuts that formerly required secondary operations in other machines. Greater accuracy and longer tool life are additional advantages resulting from the improved design.

In the automotive industry, automatic screw machines are being used widely, both for the production of simple pieces that are considered standard work for machines of this type, and for complicated pieces that formerly required operations on several machine tools. This article will describe the tooling of chucking and bar type automatics recently built by the National Acme Co., Cleveland, Ohio, for unusual applications in the automotive field.

Automobile transmission drive-shafts of the design shown at the bottom of Fig. 1 and at *A* in Fig. 3 are forged from S A E 5140 chromium steel. After they have been completely turned on the shank and recessed as indicated at *X*, Fig. 3, these drive-shafts reach a Gridley six-spindle automatic of the chucking type equipped as illustrated in Figs. 1 and 2, which completely machines the flanged end in one operation. The part is loaded and unloaded by hand in the front center position of the machine, shown in Fig. 1. Stops are provided on the front end of each spindle to locate the part lengthwise. A finished shoulder on the shank is pulled solidly against these stops when the collet is closed.

When the piece has been indexed to the front bottom position of the machine, the flange is turned for three-quarters of its length by a single-point

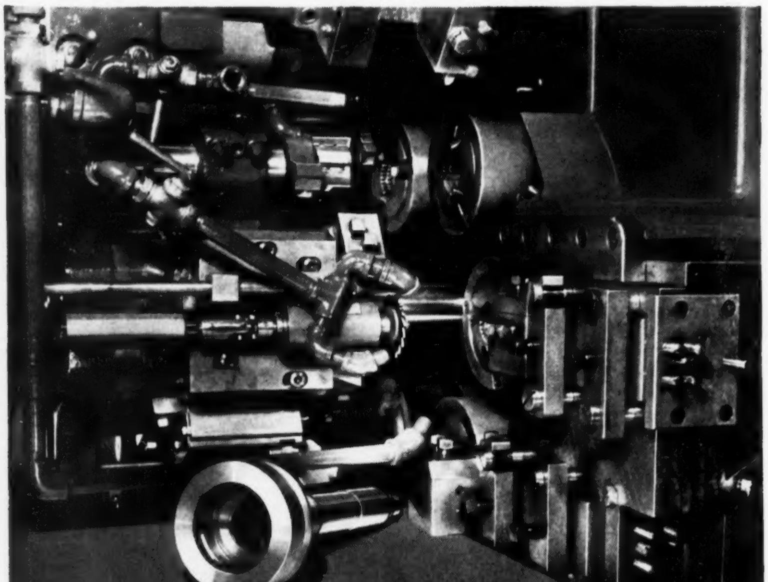


*Fig. 1. (Above) Tooling on the Front Side of a Gridley Automatic Six-spindle Chucking Machine which Finishes the Large End of Transmission Drive-shaft Forgings*

*Fig. 2. (Left) Tooling on the Rear Side of the Automatic which Machines Transmission Drive-shafts. The Average Production on This Operation is Twenty Pieces an Hour*

# Equipped Automotive Jobs

### *Automatic Screw Machines as They are Being Applied by the Automotive Industry*

tool on the main tool-slide and the punched hole in the flanged end of the part is rough-bored to two diameters by an inserted-blade cutter of stepped design, which is also mounted on the tool-slide. At the same time, tools on the corresponding cross-slide advance to face the front and back surfaces of the flange. All of these tools are illustrated diagrammatically at *B* in Fig. 3.

In the rear bottom position of the machine, the main tool-slide is equipped with a circular form cutter which produces a recess, as indicated in view *C*, Fig. 3. This tool is mounted on a fixture designed to feed the cutter sidewise to depth after it has been advanced into the work the required distance. The sidewise movement is effected as the tool-slide completes its advance. During the forward movement of the tool-slide, a single-point tool also completes the rough-turning of the flange rim. At the same time, tools on the cross-slide finish-face the front end of the piece and cut a step on the back side of the flange.

When the piece arrives at the rear center position of the machine, the narrow milling cutter seen in Fig. 2 is advanced into the work by the main tool-slide and then fed radially to cut a recess, as illustrated at *D*, Fig. 3. This milling cutter is driven through universal joints to permit the required sidewise movement which is effected in a manner similar to the operation of the recessing tool at the preceding station. The milling cutter is 5/32 inch wide and is relieved on both sides. The depth of cut is 3/8 inch.

A milling cutter is used for this operation instead of a conventional tool, because the recess must be square in relation to the bore within close limits. While the milling cutter is in operation, a tool on the cross-slide at the rear of the machine finish-faces the rear side of the flange and a second tool rough-forms a groove in the flange rim.

The tools applied in the rear top position are seen at *E*, Fig. 3. Two single-point cutters on the main tool-slide finish-turn the rim of the flange and

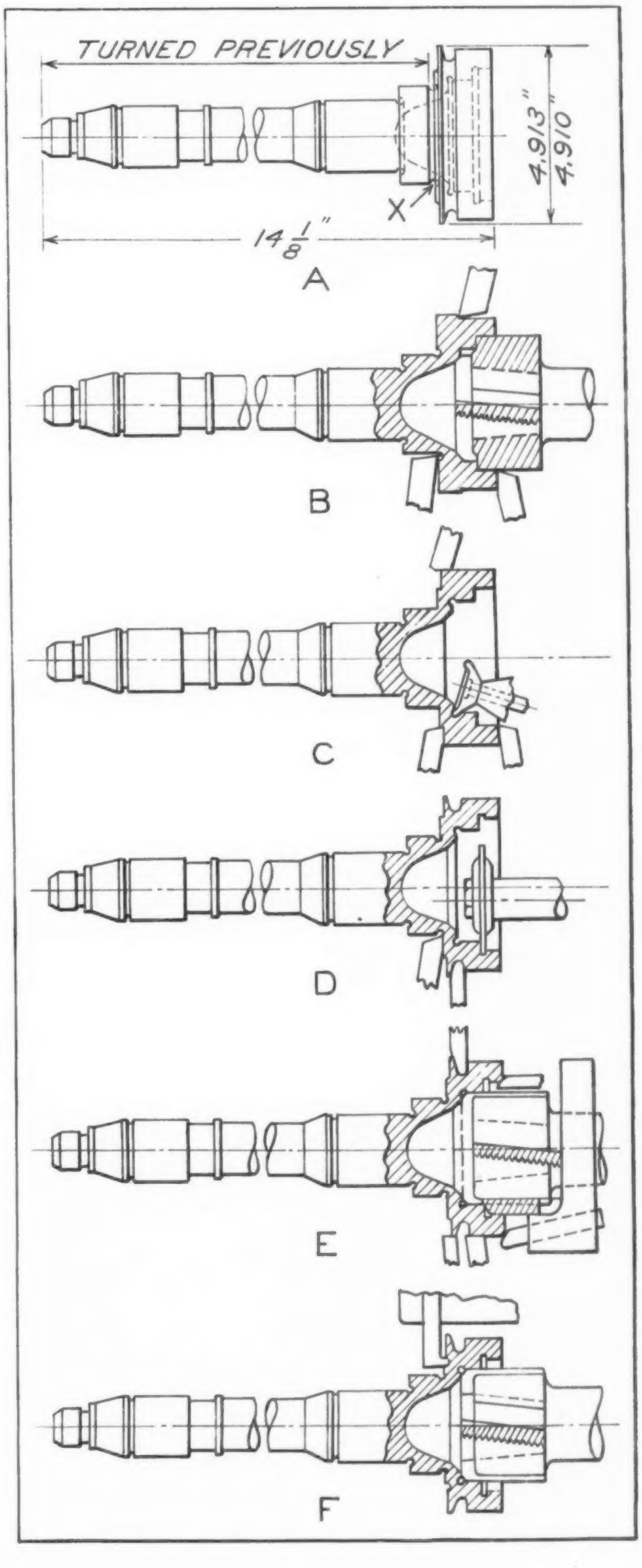



*Fig. 3. Diagrams of Tooling Used in a Gridley Automatic Six-spindle Chucking Machine for Machining the Large End of Automobile Transmission Drive-shafts Such as Shown at A*

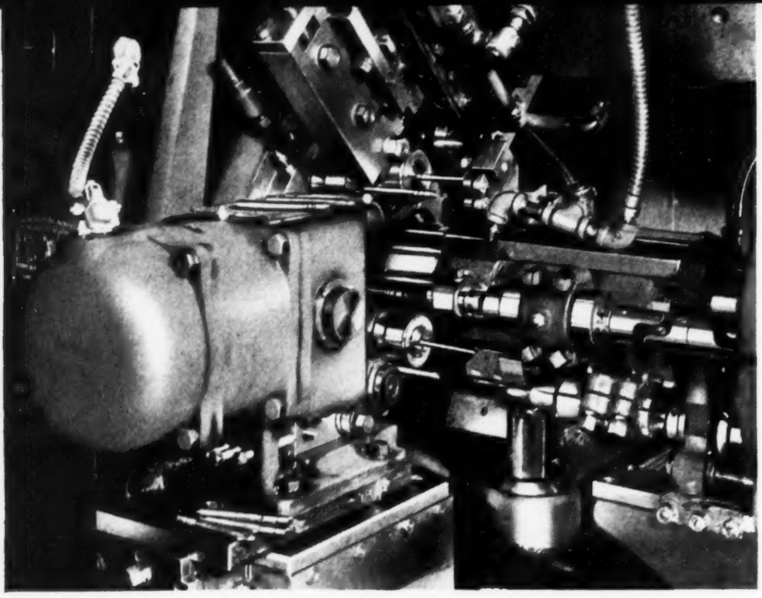


*Fig. 4. Tooling Equipment Provided on the Front Side of a Gridley Six-spindle Bar Type Automatic which Completes 480 Door-lock Spindles an Hour*

the narrow back edge which forms an oil flinger, these surfaces being finished to two different diameters. Two additional tools on the main slide chamfer the front end of the part at the outer edge of the flange and in the bore. At the same time, an inserted-blade tool semi-finish-bores the two diameters rough-bored in the first working station. A tool on the rear top cross-slide finish-forms the groove in the flange rim.

The finishing cuts are taken on the drive-shaft in the front top position of the machine by the tools illustrated in diagram *F*, Fig. 3. This station of the main tool-slide is equipped with an inserted-blade reamer which finishes the two bores and finish-faces the bottom of the large-diameter bore. As the tool-slide completes its advance, the cam-block seen in Fig. 1 comes in contact with the under side of a roller attached to the swinging arm of a fixture on the top cross-slide, this slide having previously been fed down to a stop.

The swinging movement of the cam-actuated arm causes a tool to be swung forward into the back face of the flange to form an under-cut recess. The cam angle was selected to provide the proper rate of feed. Production on this operation is maintained at the rate of twenty pieces an hour.

A six-spindle automatic equipped as illustrated in Figs. 4 and 5 was supplied by the National Acme Co. for the complete machining of door-lock spindles such as illustrated at *A*, Fig. 6. The part is machined from cold-drawn bar steel to a maximum diameter of 0.311 to 0.312 inch and to a length of 3.307 to 3.324 inches. Two important features of this job are the forming of a small eccentric hub on one end and the milling of a slot straight across the opposite end. This hub and slot are produced with the work stationary in the front center position, whereas it revolves in the other five positions, as in standard practice.

The first cut is taken on this piece in the rear bottom position, as is almost universal practice. The bar stock is automatically fed forward to an

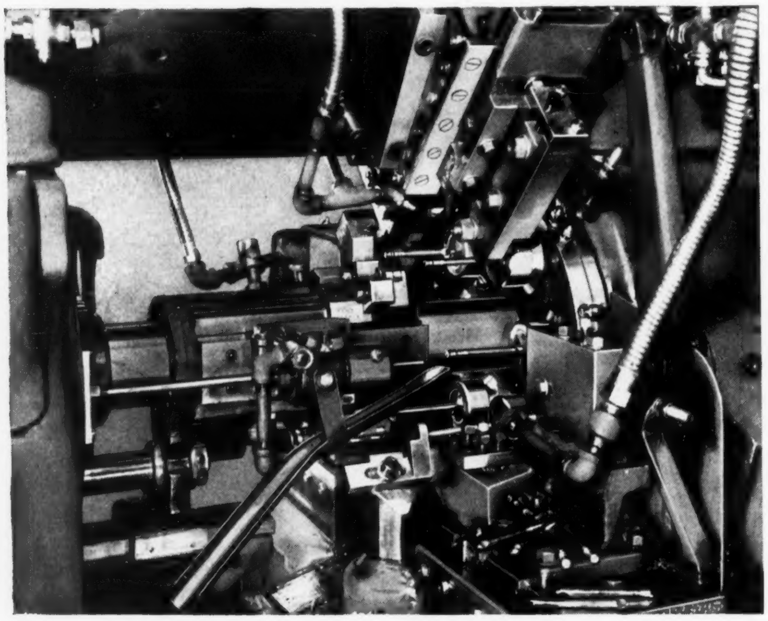


*Fig. 5. The Use of a Long Bushing in the Rear Center Position of the Machine for Supporting the Work during the Cutting off Operation Eliminates Burrs*

adjustable stop, which may be seen in Fig. 5. This stop is swung aside as the collet closes on the bar. The main tool-slide then advances, bringing a two-roller support against the overhanging end of the stock to hold it steady while a skiving cut is being taken by a tool on the cross-slide, as indicated in diagram *B*, Fig. 6. This tool takes a cut 2 3/8 inches long and reduces the diameter of the bar from 5/16 to 7/32 inch.

In the front bottom position of the machine, the tool-slide again brings a roller support in contact with the overhanging end of the bar to steady it while a tool on the cross-slide is forming this end, as indicated in diagram *C*, Fig. 6. At the same time an end-facing drill on the main tool-slide faces the end of the bar.

When the spindle has stopped rotating in the front center position of the machine, the main tool-slide advances a revolving hollow mill for machining the eccentric hub. A bushing in front of the hollow mill supports the work during this cut. The hollow mill unit may be seen on the tool-slide in Fig. 4. While this operation is in progress, the front cross-slide carries a milling cutter directly into the work for milling the notch in the left-hand end, as indicated at *D*, Fig. 6.

The work is, of course, revolving again when it reaches the top front position of the machine, where it is supported by a roller steadyrest on the main tool-slide while a form cutter on the top slide machines the left-hand end, as illustrated in diagram *E*, Fig. 6. The overhanging end of the work is similarly supported in the rear top position while a tool shaped as seen in diagram *F* takes a second forming cut on the left-hand end.

In the rear center position of the machine, a long bushing, such as illustrated in diagram *G*, is advanced over the work to support it close to the left-hand end during the cutting off. This cut is taken by a tool on the rear cross-slide. The support provided by the bushing eliminates the customary cut-off burr, because the piece is prevented from breaking off by its own weight at the end of the cut. When the main tool-slide is withdrawn, upon the completion of this cut, a small stationary bar at the center of the bushing discharges the finished piece into the chute seen in Fig. 5.

This machine completes a cycle every 7 1/2 seconds, which means that production is maintained at the rate of 480 pieces an hour.

These examples of work performed on modern automatics clearly indicate the wide range of applications for which these machines are suitable and suggest production possibilities that would have been impracticable a few years ago.

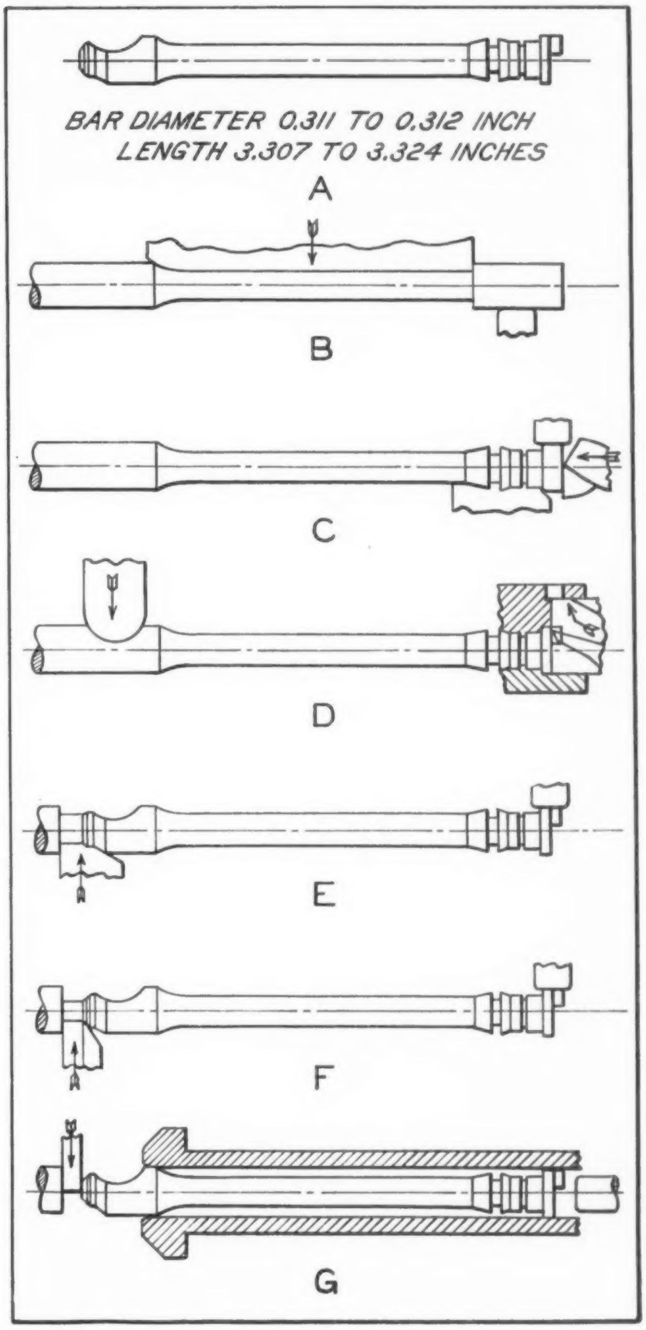



*Fig. 6. Diagrams that Illustrate the Sequence of the Cuts Taken in Producing the Door-lock Spindles*

# Ford Machine Performs

*An Inspection Machine which Upholds the Ford Tradition that Faster Production of High Quality Parts Results in Increased Employment*

STATISTICS of the Ford Motor Co. prove that the constant development of more efficient manufacturing methods results directly in steadily increasing employment. The fundamental reason for this is that improved methods enable higher quality automobiles to be manufactured at lower costs. This leads to increased sales.

One of the latest labor-saving and quality-improving machines to be developed by Ford engineers performs eleven separate inspections every minute on thirty-five valve push-rods—a total of 385 inspections a minute, or 185,000 every eight-hour shift. This machine is an outstanding example of designing ingenuity. It automatically discards a piece that fails to pass any inspection.

The push-rods are loaded vertically at the right-hand end of the machine in the manner illustrated in Fig. 2. They are placed on a silent-chain belt which carries them through a narrow slot formed by hardened and ground blocks. A cam-shaped revolving wheel that projects horizontally through one of the blocks insures that the narrow slot is kept full of push-rods. At the back of the machine the push-rods are moved around a corner by means of three fingers and into line with a reciprocating ram that pushes the pieces past the first two inspection stations. Push-rods that are accidentally fed into the machine on their side cannot get around this corner, and when this occurs, the machine stops automatically.

After the push-rods have moved around the corner, they pass a contact point that is opposite their conical end when this end is uppermost. However, should a push-rod be fed into the machine with the flat end uppermost, an electrical circuit would be completed as the part passed the contact point and a switch would be disengaged to stop the machine.

The first inspection operation consists of checking the hardness of the push-rods. As each piece reaches the scleroscope seen in Fig. 2, the hammer of the instrument falls on top of the part. If the push-rod is sufficiently hard, the hammer will rebound high enough to intercept a beam of light that passes through the scale of the scleroscope to a photo-electric cell in back of the instrument. This

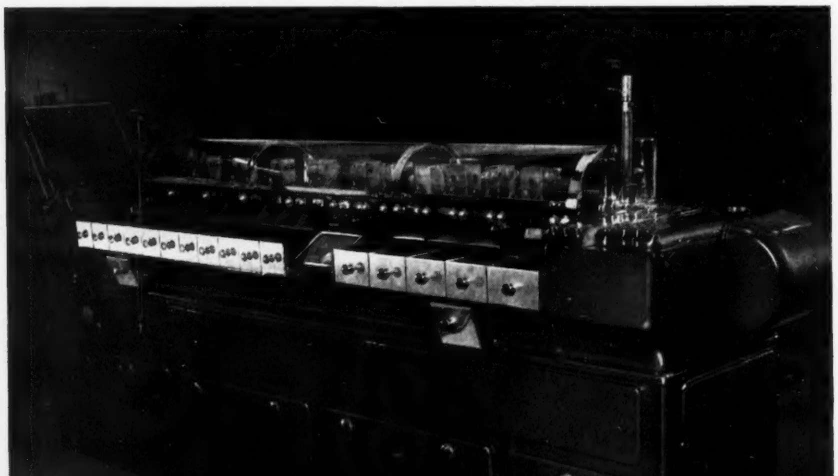


*Fig. 1. General View of the Valve Push-rod Inspection Machine which Makes 385 Inspections a Minute, or 185,000 in an Eight-hour Shift. The Machine is an Outstanding Example of Designing Ingenuity*

# 385 Inspections a Minute

*Valve Push-Rods that Meet Requirements are Automatically Sorted for Length Variations of 0.001 Inch — Those that Do Not are Rejected*

permits the push-rod to pass to the next inspection station. However, when a piece is not hard enough to meet requirements, the beam of light is not intercepted, because the hammer does not rebound sufficiently high. In that case, an electric relay operates a solenoid switch, actuating a finger that ejects the push-rod into the first of a series of drawers at the front of the machine.

At the second inspection station, a hammer strikes the side of each push-rod, and from the resulting sound, it is possible to determine when the part is cracked, defective pieces giving out a different sound that is of shorter duration than flawless pieces. This sound is picked up by a microphone and amplified by an electrical device when the tone is of a certain pitch and lasts for a definite length of time. The push-rod is then automatically transferred to the next inspection station. However, if the tone should be higher or lower than standard and the length of its duration incorrect, a second relay would be energized and a solenoid switch operated which would eject the piece into the second drawer at the front of the machine.

After the push-rods leave this station, they are automatically turned over on their sides and proceed through the machine with the conical end foremost. They are now advanced intermittently by means of a reciprocating mechanism equipped with pusher fingers which are elevated on the forward stroke so as to come in contact with the rear end of each push-rod and depressed on each return stroke so as to clear the succeeding piece. The turning of the push-rods on their sides is effected by means of two clamps which move horizontally, gripping the pieces from both sides, and then swing forward 90 degrees, releasing the pieces on the indexing mechanism.

In the next inspection station, the push-rods run on two revolving rolls, while the squareness of the flat bottom end is checked with relation to the cylindrical surface. The conical end of the push-rod bears against a locating point of the inspection device, while the flat end is supported near the outer edge by a swinging arm. If the push-rod face is not square, the opposite end of the swinging arm

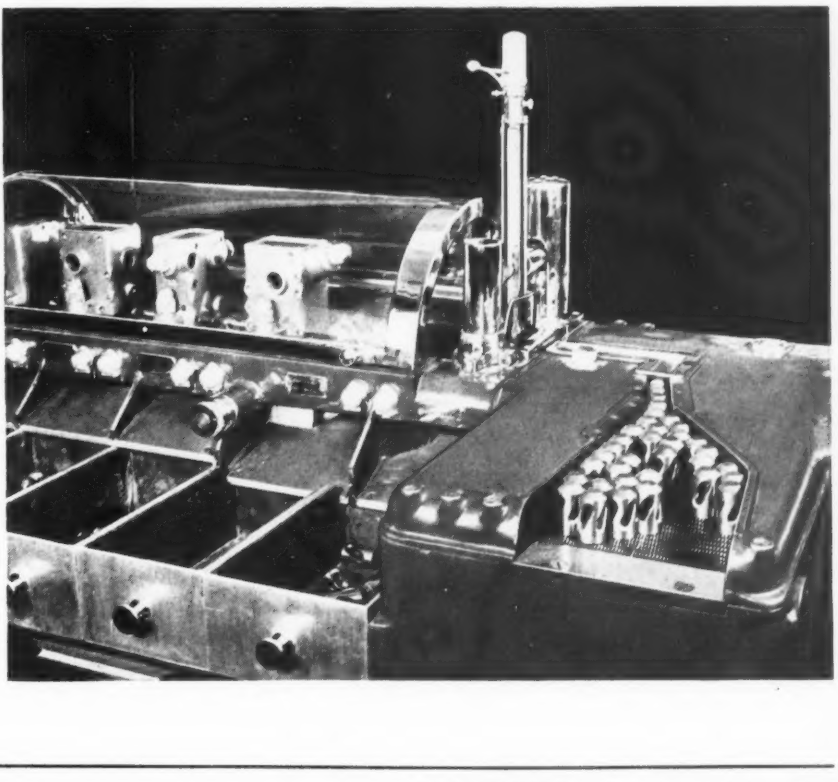


*Fig. 2. Loading End of the Inspection Machine which Checks Thirty-five Push-rods a Minute for Hardness, Cracks, Diameter, Squareness, and Roundness, and Sorts Them for Length Variations of 0.001 Inch*

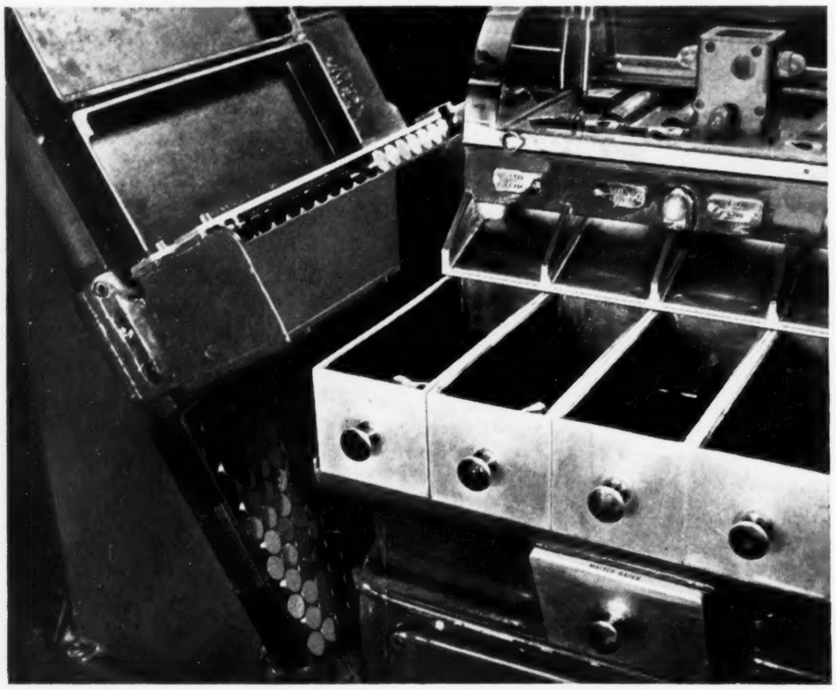


*Fig. 3. Valve Push-rods that Pass All Inspections and are of the Medium Length in the Permissible Range are Automatically Loaded into Boxes by an Ingenious Mechanism on the Far End of the Inspection Machine*

will rock and make an electrical contact that will energize a relay and solenoid switch, thus ejecting the piece from the indexing mechanism after it leaves the inspection station. All push-rods that meet the requirements are, of course, passed on to the next station.

The fourth inspection consists of checking the roundness of the cylindrical surface, and the fifth inspection of checking the squareness of the small flat surface on the conical end. Push-rods that fail to pass these inspections are ejected in the same manner as at the preceding stations. As the push-rods approach the sixth inspection station, they are so located on the indexing mechanism that the center of one of the helical slots is at the top of the piece. This enables the thickness of the walls at the top and bottom ends to be checked by means of fingers which enter the slots and come in contact with the walls. The outer front end of the push-rod is located against a stop by a spring plunger that bears against the opposite end. Push-rods that are too thin on the ends are ejected into a drawer.

The parts are next gaged for diameter of the cylindrical surface between the slots. If under size, they are ejected into one drawer, and if over size, into another. A special electrical circuit and double-delay mechanism are required for this purpose. The diameter of the push-rod at both ends is now checked by means of two sets of contactors, and again, under-size and over-size parts are ejected into different drawers.

The next three inspection stations are identical. They gage the push-rods for length, eject those that are over size or under size and sort the remaining sizes according to steps of 0.001 inch. The first station rejects push-rods shorter than 1.720 inches and longer than 1.725 inches. The next station selects push-rods from 1.720 to 1.721 inches long and from 1.724 to 1.725 inches long, rods of these two lengths being discharged into separate drawers. The next station selects lengths from 1.721 to 1.722 inches and from 1.723 to 1.724 inches and sorts push-rods of these two lengths into different drawers. The intermediate length of 1.722 to 1.723 inches is checked by the last inspection station of the machine, and these push-rods are then automatically stacked in hard rubber boxes by the ingenious mechanism seen in Fig. 3.

Sixteen push-rods are automatically loaded in each row of this box, and each time that a row is completed, the box is automatically lowered to receive the next row. When twelve rows have been completed and the box filled, a buzzer is sounded automatically, and after twenty seconds, the machine stops operating and remain inactive until the full box has been replaced by an empty box.

In addition to the ingenious mechanical and electrical features, the appearance of the machine has been given careful attention. All wiring, electrical equipment, and mechanical units are completely concealed by panels within the machine housing and yet are readily available, as will be seen from

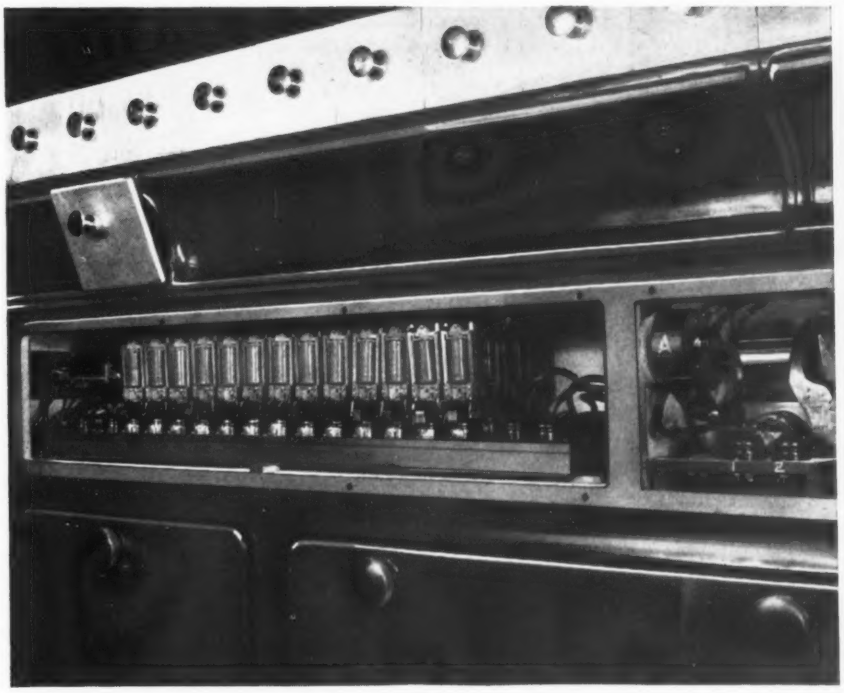


*Fig. 4. All Electrical and Mechanical Equipment of the Inspection Machine is Completely Enclosed and Yet is Readily Accessible by Removing Panels. In the Illustration a Panel is Removed, Showing Twenty-five Relays*

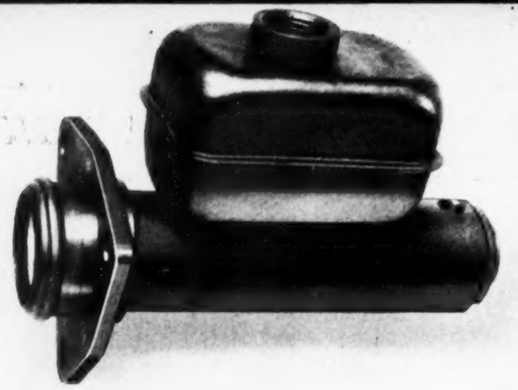
Fig. 4, which shows one panel removed, so as to make accessible the twenty-five relays which control the operation of the solenoid switches. Such external parts as the drawer knobs and the housings for the photo-electric cell and its lamp are chromium-plated. Attractive caps made from soy-bean plastic compound protect the contact screws of the inspection devices, and small aluminum die-castings cover the fittings of the grease tubes that lubricate the various moving parts. Covers of cellulose-acetate protect the inspection devices from dirt and at the same time give a clear view of the push-rods passing through the machine.

On the front of the machine is a panel that indicates how much voltage is passing into the machine, whether the current is being supplied to the various solenoid switches, and which unit has failed to function when the machine stops automatically. Enclosed in the back of the machine is a timing drum which is scribed to indicate the correct positions for the various cams that control the machine movements.

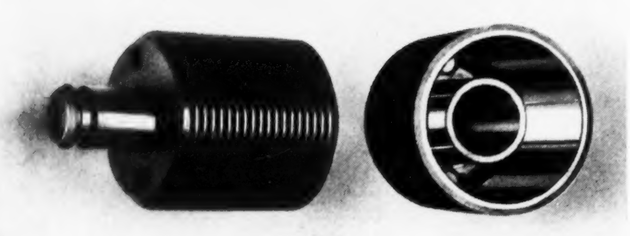
# *Working Conditions in the Automobile Industry*

AUTOMOTIVE workers draw the highest wages paid in any manufacturing industry, and their hours, according to the Bureau of Labor Statistics —40.1 per week last October—have been slightly less than the average of other industries—41.3. Automobile manufacturers also rank first among seventeen important manufacturing industries, surveyed by the National Industrial Conference Board, in their employes' health programs. No other industry has gone so far in supplying plant nurses, organized first aid, optical clinics, doctors' services, plant hospitals, physical examination of both new and old employes, health and accident insurance, and in promoting safety.

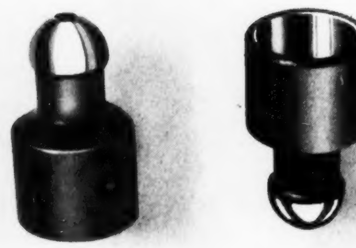
Educational facilities and training for promotion are other important aspects of factory operation from the workers' standpoint; not only in a general way, but more specifically, through apprentice training and training of unskilled and semi-skilled workers, the automobile plants rank either first or among the highest of the seventeen industries surveyed. Automobile factories are also among the leaders in such miscellaneous activities as providing free legal aid, group life insurance, and Christmas bonuses. Last Christmas, the General Motors Corporation, for example, paid a special "appreciation fund" amounting to from $35 to $60 cash per employe.



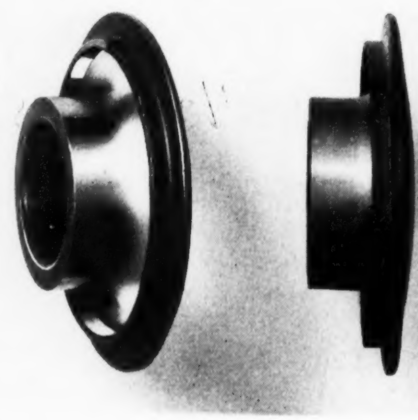
1



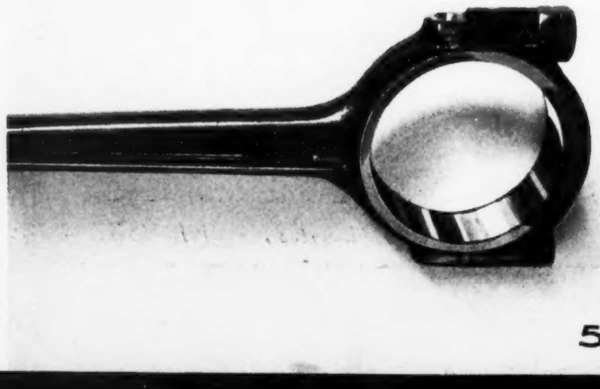
2



3



4



5

# *Precision Boring in Automotive*

PROBABLY the greatest contribution of machine tool builders to the automotive industry has been the development of machines capable of finishing parts within a few ten-thousandths inch at the rate of a hundred or more pieces an hour. One of the latest types of machines belonging to this classification is the precision boring machine, which was brought out primarily to take full advantage of the possibilities of carbide-tipped and diamond tools in boring operations. The success of these machines has also led to their extensive application for the turning and facing of parts to close dimensional limits.

Boring the ends of automobile connecting-rods and the piston-pin holes of pistons soon became standard jobs for precision boring machines, and they are now almost universally applied for these operations. Another outstanding application is the precision-boring of V-type cylinder blocks accurate as to diameter within a tolerance of 0.0005 inch, and straight and round within 0.0003 inch.

Precision boring in the automotive industry however, is not confined to these better known parts, as will be apparent from the accompanying illustrations, which indicate the ever widening application of the process. All of these parts are being precision turned or bored on standard machines built by the Ex-Cell-O Aircraft & Tool Corporation, Detroit, Mich. The master hydraulic brake cylinder shown in Fig. 1 is constructed of steel stampings and a piece of seamless steel tubing, hydrogen-brazed together to form an oil-tight assembly. The tube of this part is precision-bored to a diameter of 1.25 inches, within plus 0.003 inch and minus 0.000 inch, for a length of 4 3/8 inches to a blind end. The depth of cut on the diameter is 0.015 inch, the feed 0.004 inch, and the spindle speed 1700 revolutions per minute.

This operation is performed on a two-spindle machine by a method differing from usual practice in that the work-fixture first advances toward the boring tools, which have been positioned to clear the rough bore, until the tools reach the blind end of the tubes without a cut being taken. The fixture now moves sidewise to bring the tools into position for cutting to the required depth. The boring spindles then start rotating and the boring

# and Turning Shops

By C. A. BIRKEBAK

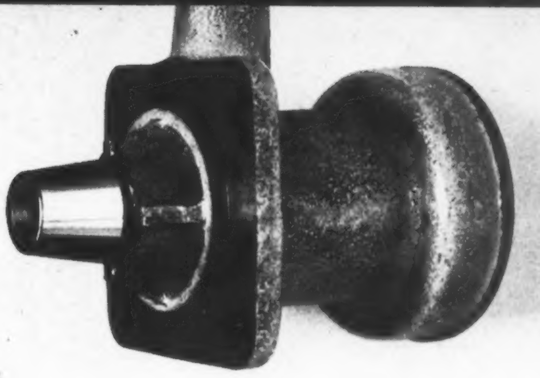
cuts are taken as the fixture moves away from that end of the machine, so that the tube is finished from the inner end to the outer end. The production is a hundred pieces an hour, or fifty pieces per spindle. Carbide-tipped tools are used, as in most other precision boring operations on steel and cast iron. On parts made from non-ferrous alloys, diamonds are used extensively.

In Fig. 2 is shown a brass carburetor part in which two holes are precision-bored simultaneously, concentric within 0.0005 inch. The small hole is approximately 1/2 inch in diameter by 3/4 inch long, and the large hole, 1 1/8 inches in diameter by 1 1/8 inches long. Both holes are bored to blind faces. A difficult feature of this operation was to provide a tool-holder rigid enough to bore the outer hole past the projecting central boss in which the small hole is bored, the available space for the tool-holder being less than 1/4 inch wide. Both tools are mounted on the same holder, supported on the machine table, but they are adjustable individually. The average production is a hundred pieces an hour.

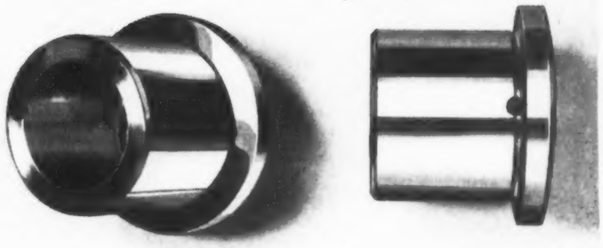
The ball-end valve tappets for airplane engines, shown in Fig. 3, are made of steel and heat-treated to a hardness of approximately Rockwell C-19. They are rough- and finish-bored after the heat-treatment in two steps on a two-spindle double-end precision boring machine. The countersunk bottom or blind end of the hole is faced flat in the same operations.

In taking each of the boring cuts, the machine table on which the tools are mounted first rapidly traverses the tool into the work which is rotating, until the tool is within a few thousandths inch from the blind face. Then this face is machined with a plunge cut, at the end of which the tool dwells momentarily. The table now moves sidewise to bring the tool to the desired depth, and then the table reverses at a boring feed, so that the hole is bored from the inside end to the outside. When the part has been rough-bored, it is transferred to the opposite spindle of the machine for finish facing and boring.

The hole in this part is approximately 9/16 inch in diameter and is bored to a depth of 7/16 inch. The tolerance for the hole diameter is 0.001 inch,

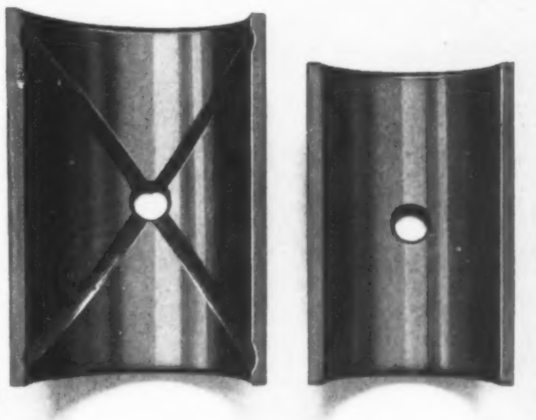


6

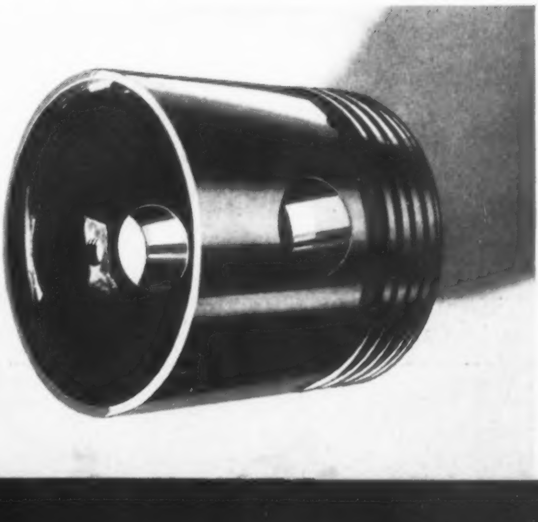


7

8



9



10

## PRECISION BORING AND

*Fig. 11. Precision Boring, Turning, Grooving, and Facing Tractor Pistons in One Machine which Gives a Production of Twenty-seven Pistons an Hour*

and the tolerance for the distance from the blind face to the outer ball end is 0.005 inch. From 0.010 to 0.012 inch of stock on the diameter is removed in the two cuts. The feed is 0.002 inch, and the spindle speed 2300 revolutions per minute. The production is one hundred and twenty complete pieces an hour.

Precision turning and boring operations are performed on the valve-spring retaining washer illustrated in Fig. 4, this part being turned along the boss, then generated upward toward the face at a radius, next faced, and finally bored to the outside edge of the narrow flange that runs around the face. This flange is only about 1/32 inch thick and is bored to a diameter of 1 9/16 inches. The tolerance for the outside diameter of the hub and the inside diameter of the bore is 0.005 inch.

The machine movements are actuated hydraulically, the work-fixture moving with respect to the spindle that carries the work. This part is heat-treated to a hardness of Rockwell C-38 to C-43 prior to the operation. In turning and boring, the average production is sixty pieces an hour.

The large end of the connecting-rod illustrated in Fig. 5 is precision-bored in steel to 2.220 inches, plus or minus 0.0002 inch, the depth of cut varying from 0.0075 to 0.009 inch, and the spindle running at 680 revolutions per minute. The feed is 0.0058 inch. Other connecting-rods are precision-bored in the large end, after they have been babbitted and are also precision-bored in the bronze-bushed small ends.

The Diesel-engine fuel-pump part illustrated in Fig. 6 has a hole 1 inch in diameter that is precision-bored to a depth of 1 7/8 inches from the large end. Then the part is placed on the opposite side of the two-spindle precision boring machine, and a small hole of 3/8 inch in diameter is bored a distance of 1 1/2 inches to the bottom of the large hole. In the second step, the part is located from the previously bored hole. The alignment of the two holes is held within 0.0005 inch. The diameter tolerance is 0.0002 inch. This part is made from a nickel-iron casting.

The duralumin pieces seen in Fig. 7 are end plugs for the wrist-pins of aircraft engines. Turning, facing, and generated cuts are taken on these parts in two operations on machines of the precision boring type. In the first operation, the part is turned along the main portion to a diameter of about 1 inch, faced on the inside of the flange, and turned on the flange to a diameter of 1 5/16 inches. The work piece is held on an expansion arbor in the spindle and the turning tools are mounted in a fixture on the machine table. Facing of the flange is done with tools on an auxiliary slide. The second operation consists of generating the radius on the closed end of the piece.

A high degree of finish is the important point in these operations, but there is a limit of 0.005 inch specified on the distance from the inside of the flange to the high point of the rounded end. The diameters are held to size within 0.001 inch. One operator runs two machines, the production of each machine being eighty pieces an hour.

The casting shown in Fig. 8 is a magnesium gear housing for aircraft applications. It measures approximately 8 inches maximum diameter by 3 1/2 inches overall length. This housing has three holes in it which are first rough-bored and then precision-bored to diameters ranging from 1 1/4 to 2 1/16 inches, all of which must be finished within 0.0005 inch of the specified dimension. The large hole in the center is fitted with a steel bushing, which is precision-bored to the maximum diameter mentioned, but the other two holes are bored in the magnesium. The hole to the left of the central hole is counterbored to a depth of 1/2 inch from each end of the part, the hole between these counterbores being left unfinished.

Half-bearings of copper alloys are precision-bored for the engines of automobiles, trucks, and tractors. The bearings are steel-backed, being shaped from flat steel stock which has been coated with a copper-lead alloy on one or both sides. These half-bearings are turned to a diameter of 2.220 inches and precision-bored. The half-bearings are bored or turned one at a time.

At the left in Fig. 9 is seen a tractor bearing which has an inside diameter of 2 5/8 inches and a length of 4 1/2 inches, while at the right is a truck bearing with an inside diameter of 2 1/8 inches. The second piece is also of the steel-backed type, the thickness of the outer steel shell being approximately 5/32 inch, while the copper-alloy coating is 1/32 inch. The wall thickness of half-bearings of this type is held uniform within 0.0003 inch.

On large grooved bearings, such as seen at the left of the illustration, the average production is thirty-three pieces an hour. Diamond tools are used for this operation, the depth of cut being from 0.004 to 0.005 inch, the feed 0.002 inch, and the spindle speed 2000 revolutions per minute. Small bearings 2 inches inside diameter by 1 3/8 inches long are bored at rates as high as two hundred and sixty an hour with a spindle speed of 3500 revolutions per minute, a feed of from 0.0015 to 0.002 inch, and a depth of cut averaging 0.005 inch.

Pistons are universally precision-bored in the piston-pin holes, and machines of the precision boring type are also being used extensively for turning these parts. The different methods vary somewhat with production requirements, as was explained in two articles published in April and May, 1935, MACHINERY.

A rather unusual application of a precision boring machine in a tractor shop where the production schedules are not so high as in the average automobile plant is illustrated in Fig. 11. Five distinct operations are performed by a machine which has two spindles at each end. In the first station of this machine, which is at the right rear, the dome end is faced and five ring grooves are simultaneously turned on the piston by tools mounted on a head at the back of the machine. This tool-head is fed forward hydraulically after the table has been fed toward the right to bring the tools into the correct position relative to the piston. The piston rotates at a speed of 1440 revolutions per minute, while the feed is 0.0025 inch.

At the same time, a piston that has already been faced and grooved is having a spherical seat turned in the dome end at the right front of the machine. This cut is taken by a tool on the table, which is swiveled on a bearing by automatic means. While this cut is being taken, the piston rotates at 2400 revolutions per minute, and the feed is 0.0015 inch.

The circumference of the piston is turned at the left front station by a tool that is mounted on the table, this cut being taken as the table feeds from right to left; during this operation, the spindles at the right-hand end of the machine are being reloaded. The speed of the piston during the turning cut is 1440 revolutions per minute, and the feed 0.0025 inch, the piston being turned to a diameter of 4 1/4 inches.

Simultaneously, a piston in the left rear position of the machine is having the piston-pin holes precision-bored. For this operation, the piston is mounted upright on the table and the cutter is held in a machine spindle which rotates at 2400 revolutions per minute. The piston-pin holes are bored to a diameter of 1 3/4 inches. The depth of each cut is from 0.004 to 0.005 inch, the piston being made of Lynite. The average production is twenty-seven pistons an hour.

The unusual precision boring operation illustrated in Fig. 12 consists of first finish-boring six holes to a diameter of 1.750 inches in a steel propeller shaft for airplane engines, and then boring six bronze bushings that are fitted into these holes. For this operation, the single-spindle machine is equipped with an indexing fixture which accurately locates the successive holes in line with the boring spindle. In the steel boring operation, the tool-spindle runs at 975 revolutions per minute, is fed 0.003 inch per revolution, and cuts to a depth of 0.005 to 0.0075 inch. Five propeller shafts are finished per hour.

In boring the bronze bushings to a diameter of 1.498 inches on the same machine, the tool-spindle runs at 3000 revolutions per minute, is fed 0.0015 inch, and cuts to a depth of 0.004 to 0.005 inch. The production is eight propeller shafts an hour.

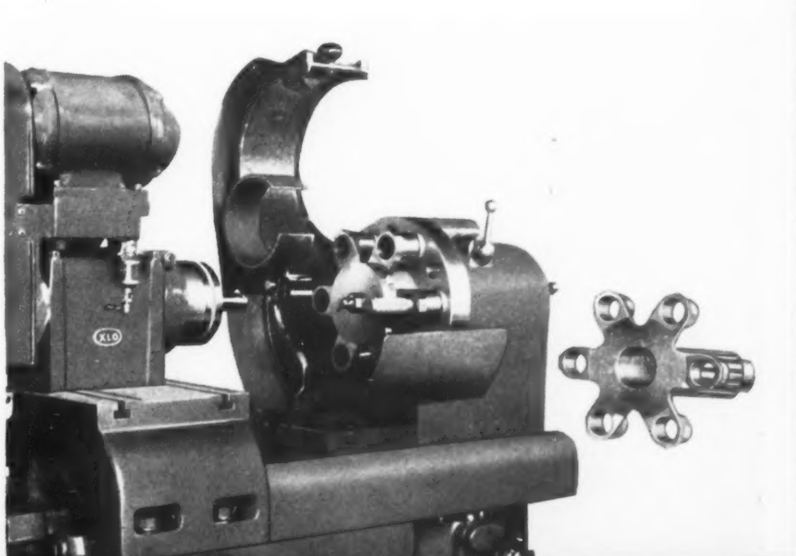


*Fig. 12. Airplane Propeller Shafts of Heat-treated Alloy Steel are Precision-bored to Receive Six Bronze Bushings, which are Also Precision-bored*

# *Unique Inspection Methods in the*

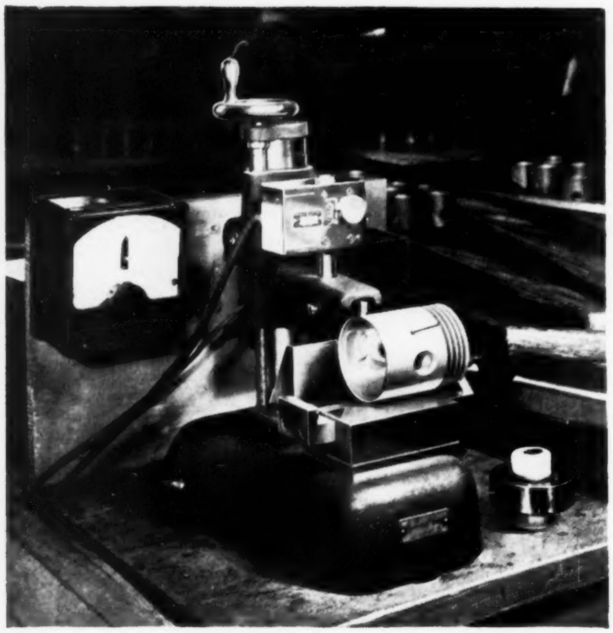


*Fig. 1. Electrolimit Gage which is Used for the Accurate Inspection of the Skirt End of Plymouth Pistons after Anodic Plating*

*Fig. 2. Cooling Units Bring Each Piston to Room Temperature for Inspection Purposes Immediately after They Leave the Hot Rinse Following Anodic Plating*

ANODIC plating is the last manufacturing operation on Plymouth pistons, except for the final inspection of the skirt diameter, which follows immediately. The plating process forms a coating of aluminum oxide approximately 0.0002 inch thick all over the pistons, making them harder and longer wearing.

Owing to the high temperature of the pistons as they come from the hot water rinse at the end of the anodic plating operation, it was formerly impossible to check the pistons at once. This difficulty has been solved by the installation of the four cooling units or "refrigerators" seen in Fig. 2, to which the pistons are conveyed directly from the hot water rinse. Each of these cooling units consists of an insulated tank of square cross-section, having a long thin-walled tube in the center which is welded to the tank at both ends, so as to be water tight.

Water circulated within the tank completely surrounds the tube and thus provides an atmosphere in the tube, the temperature of which can be controlled by means of a hot- and cold-water mixing valve. A gage on top of the tank records the temperature within the tube.

A chain conveyor with work-pushing fingers carries the pistons through the tubes of these cooling units from right to left. The rate of conveyor movement is such as to insure that when the pistons leave the discharge end of the cooling unit, they will be at room temperature or at any other temperature that may have been selected for check-

# Plymouth Plant

ing purposes. Each cooling tank measures 5 feet long by 14 inches square. It takes about two and a half minutes for a piston to travel from one end of the tank tube to the other.

As the pistons leave the cooling units, they are placed on Pratt & Whitney Electrolimit external comparators of the type illustrated in Fig. 1. These comparators are equipped with a Micro-ammeter which has a large graduated dial that insures inspection accuracy at full-speed production. This dial also eliminates eye fatigue in checking and grading the pistons according to variations of 0.0005 inch in the diameter of the skirt end. The minimum diameter is 3.1245 inches, and the maximum diameter 3.1265 inches.

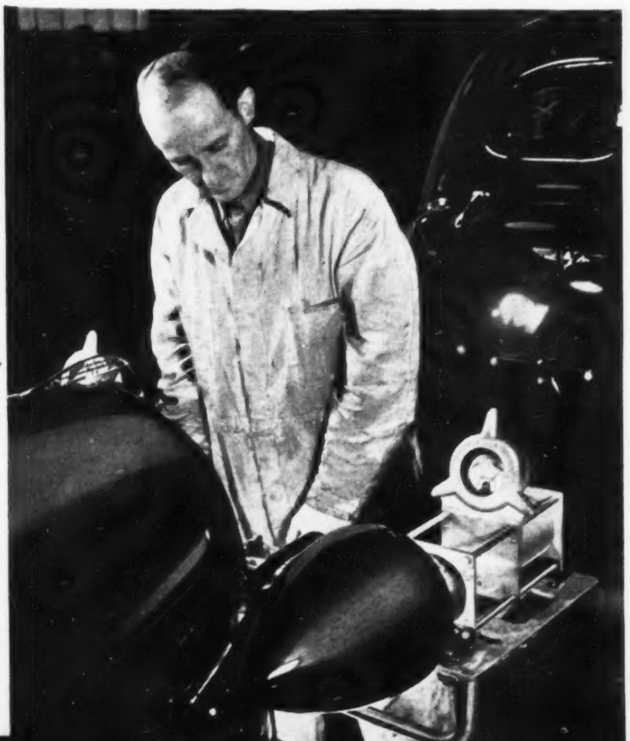
The pistons are located on the comparator by means of an anvil and back-stop, fitted with tungsten-carbide inserts to prevent wear, while the spindle is provided with a diamond point for the same purpose. There is a compensating device that holds the maximum pressure on the pistons to 4 ounces, thus eliminating distortion and errors in the grading. The master ring gage seen at the right of the comparator base is used for setting purposes.

Electrolimit gages provided with a pistol grip are used as shown in Fig. 3 for checking cylinder bores and grading them for diameter variations of 0.0005 inch. The bore diameters are marked and chalked by the inspector and then stamped with steel stencils. The gaging head is connected electrically to a power unit and to a large-dial Micro-ammeter at the back of the conveyor line.

*Fig. 3. (Above) Electrolimit Gages with Pistol Grips are Employed for Checking Cylinder Bores and Grading Them for Variations of 0.0005 Inch in Diameter*

*Fig. 4. (Below Left) An Inspection Fixture with Condensing Lenses, Photo-electric Cells, and Micro-ammeters is Used for Accurately Focussing the Head Lamps of Automobiles*

*Fig. 5. (Below Right) View of the Head-lamp Focussing Fixture from the Front, Showing the Manner of Mounting it on the Automobiles as They Approach the End of the Assembly Line*



Temperature also plays an important part in the inspection of cylinder blocks, and on this account, the master ring gages used in setting the cylinder bore gages are kept in a cabinet that is maintained at a constant temperature. Also, since it was found that the assembly of cylinder-head studs causes a slight distortion in the cylinder bores, these studs are now assembled before boring and honing.

The focus of all head lamps is carefully adjusted by means of fixtures of the type illustrated in Figs. 4 and 5, which employ photo-electric cells to determine the intensity of the light rays. The intensity is recorded on Micro-ammeters, as seen in Fig. 4.

The various units of this device are mounted on an aluminum frame, equipped with two arms which are hooked over the head-lamp brackets. On the lower cross-bar of this frame, as may be seen in Fig. 5, is a locating device, the bottom end of which is placed in contact with the radiator grille. The upper end is then adjusted by means of a hand knob and screw until a spirit level on the upper cross-bar of the frame indicates that the frame has been correctly positioned.

After the fixture has been leveled, each head lamp is adjusted so that its beam of light is projected through the center of the corresponding condensing lens on the fixture, which is 2 1/2 inches in front of the head lamp. The light rays are focussed by this lens on the front end of the housing which contains the photo-electric cell. There is a 1/8- by 1/4-inch aperture on the housing which can be adjusted to control the ray of light that is projected through the aperture on the photo-electric cell. This cell is connected to the Micro-ammeter on top of the housing, which gives a reading of the light intensity. The housing that contains the Micro-ammeter is suspended by three springs which protect it from damage in use.

After a head lamp has been adjusted until a maximum reading is recorded by the Micro-ammeter, the operator tightens the head lamp on its bracket from the position seen in Fig. 5. The complete fixture weighs about 28 pounds, and is transferred by the operator from automobile to automobile as they come along the assembly line.

The master gage used in setting these head-lamp adjusting fixtures is a duplicate of the front end of a car. Alternating current is used to light the lamps of the master gage. This, in turn, requires a transformer, rheostat, and voltmeter for reducing the voltage to that of a storage battery. In the actual inspection of head lamps on assembled automobiles, the lamps are, of course, lighted by the batteries which have been installed on the cars.

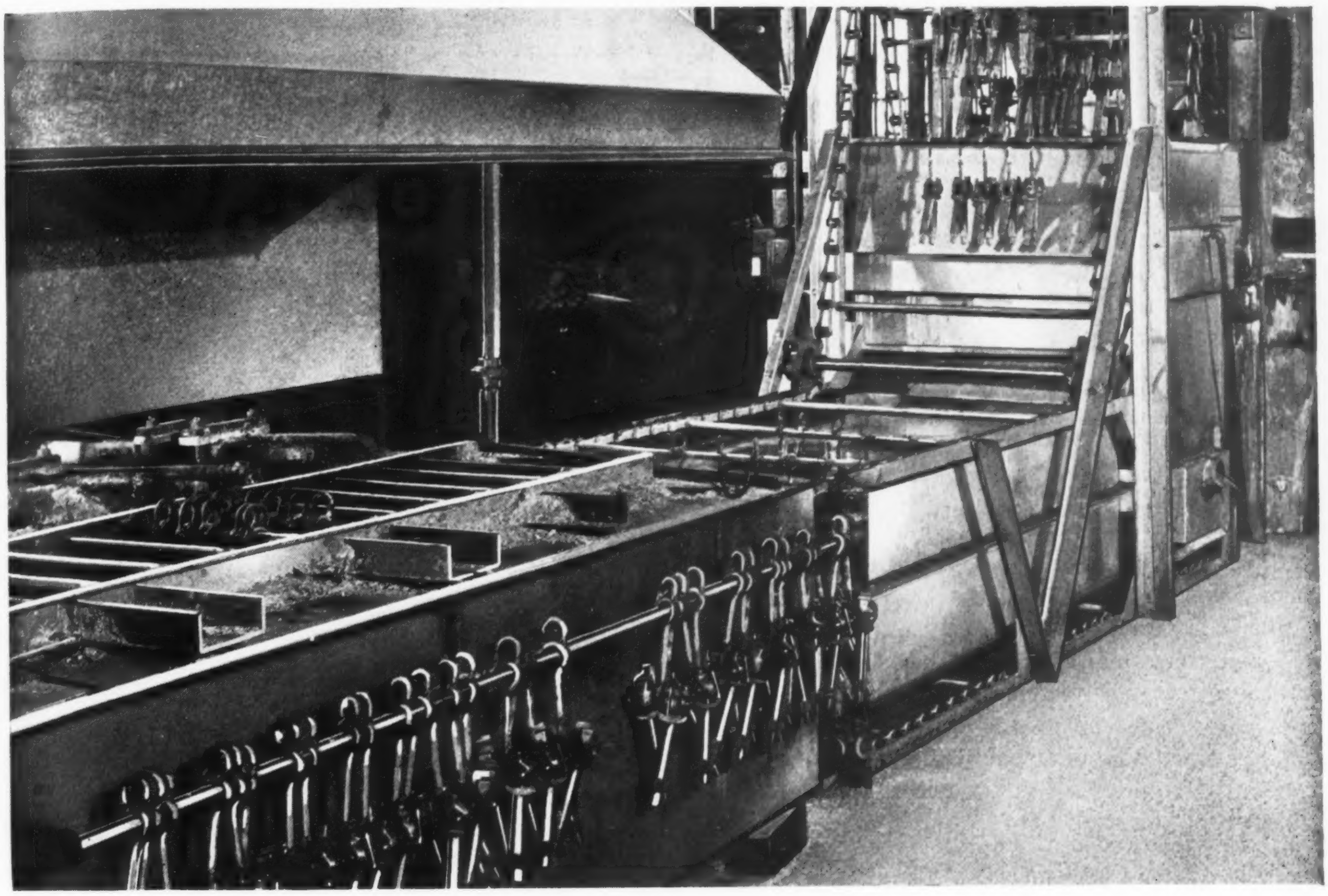
# Production Hardening in an Electrically Heated Salt Bath

STEERING-GEAR shafts, worm-gears, and other parts made of alloy steel are casehardened on a production basis by the Gemmer Mfg. Co., Detroit, Mich., in an electrically heated salt bath. This hardening process is performed in the Ajax-Hultgren furnace here illustrated (Ajax Electric Co., Philadelphia, Pa.), which consists essentially of a pot 6 feet long by 25 inches wide by 18 inches deep inside. The calcium cyanide casehardening salt known as Aerocase (American Cyanamid & Chemical Corporation, New York City) is used, which provides an activated chloride bath.

About 2500 pounds of this compound can be melted in the furnace at one time. A molten bath is obtained by melting Aerocase No. 510, which is used in powder form and serves as the heating medium. Then Aerocase No. 28 is added in small quantities at regular intervals to maintain uniform carburizing activity. This compound is supplied in block form for convenience.

Three pairs of metal electrodes are suspended close together in the bath from the rear wall. Alternating current passed between the electrodes melts the salt and heats the bath by direct resistance. By locating these electrodes in close proximity, the heating zone is restricted to a comparatively small section of the furnace, thus leaving a large proportion of working space.

Uniform heating of the entire bath is obtained by means of a patented arrangement of the electrodes which utilizes electromagnetic forces in such a manner that the entire bath is constantly stirred. The molten salts are drawn between the



*Gemmer Steering-gear Shafts are Casehardened by Immersing them in an Electrically Heated Salt Bath and Quenching in Oil*

electrodes and forced downward toward the bottom of the pot, thus providing a positive circulation of the hardening medium. The furnace operates on 220-volt, three-phase, sixty-cycle current, a transformer being used to provide current of low voltages to the electrode terminals. Because of the low voltage, there is no danger of the furnace operator receiving shocks.

The furnace pot is simply constructed of steel plates, welded together and embedded in insulating firebrick. Scaling or corrosion, which occurs when furnaces are heated from the outside, is of course eliminated, and the bath salts do not have any corrosive effect on the inside of the pot. There is, however, gradual carburization and some crystalline growth due to the prolonged heating, but it is estimated that the pot will give at least one year's service before it need be replaced.

Uniform hardness of the product is one of the important advantages of this casehardening method, and this results from the ease of holding the furnace to the same temperature throughout, as well as maintaining a positive control of the cyanide content of the bath. Production heats can be maintained day and night with a variation not exceeding 5 degrees. It is the practice to keep the furnace just above the freezing point over weekends and during other periods when it is not in use, so as to avoid the expense of remelting the hardening compound.

The illustration shows this furnace being used for the hardening of steering-gear shafts. It is operated at 1525 degrees F. The shafts are suspended from hooks. After being heated for the required length of time, they are transferred to the conveyor type quenching and tempering equipment seen at the right of the illustration, where they are immediately quenched in oil, conveyed through a cleaning bath, and then carried into a gas-fired tempering furnace, where they are held at 400 degrees F. for a specified time.

The serrated ends of the shafts are drawn in a subsequent operation by immersing them in a nitrate bath and quenching in water.

# Steel Castings for Automobiles

*Some of the Reasons why Steel Castings are Rapidly Gaining Favor with Automobile, Truck, and Bus Designers*

*By RAYMOND L. COLLIER*

AUTOMOTIVE engineers have acquired an enviable reputation for being keenly alert to the progress made in every field that has a bearing upon progress in their own. Their open-minded approach to all the mechanical problems of their industry is probably the principal reason for America's front-line position in the automotive field.

Nowhere is this open-mindedness more apparent than in the study and ready acceptance of new or improved materials. The fact that cast steel is now being selected for so many vital truck, bus, and trailer parts is a tribute to the art of the steel foundryman. Cast steel has proved to be the final answer to many structural problems requiring in their solution high quality, low cost, and dependability. Perhaps this progress and the reasons for it can best be exemplified by a number of quotations from men engaged both in the automotive and in the steel foundry industries.

A steel foundryman is quoted as follows: "We make a great many gear shifting forks used in automobile, truck, and bus transmission cases. This shifting fork is a sprawly casting which may be forged when the quantity permits. Recently, when calling on one of our customers, we were told that the engineering department had changed from a forged fork to a casting. When we asked 'why', we were told that in heat-treating, a casting distorts less than a forging. These forks have to be held to very close limits and it is difficult to correct the distortion and stay within the required limits.

"The reason is easy to see. The structure in a casting is uniform, but when a piece of bar stock is upset, forged, and often twisted, in producing a part, the structure is changed and distorted; when subjected to heat, the material attempts to readjust itself, and in so doing causes the machined forging to warp. It is difficult to realign the machined surfaces."

The next quotation is from an article by R. H. McCarroll and J. L. McCloud, both of the Ford Motor Co., as recorded in *Metal Progress*.

"This housing is an example of the economical advantage of a steel casting, since the metal may be properly distributed in it to meet the design requirements. Each half was formerly a welded assembly of a steel tube with malleableized iron bell and steel forgings. Actually, the casting weighs less than the former assembly, and is equal in rigidity or stiffness. The savings achieved are due to reduced machining costs with less metal to remove and the elimination of the welding formerly required."

The same authors proceed to say: "In order to get a mental picture of this new type of wheel assembly, consider that the former practice was to use a steel forging for the hub with a gray iron ring for the braking surface. The loads that this new alloy steel casting has to withstand, acting as combination hub, wheel center and brake-drum, come from all directions and are not only static but dynamic.

"Just as indicated before, the combined hub, drum, and wheel center presents a case where in-

*Fig. 1. Cast-steel Truck Wheel-hub Castings, Fabricated and Assembled by a Combination of Welding, Machining, and Bolting*

creased strength is secured, together with lower weight—unsprung weight. Too much emphasis cannot be given to this. The reason is that in castings, metal can be placed where it is wanted; we are not limited by requirements of draft in the forging dies, and may have ribs where we want them.

"The new and lighter cast-alloy steel hub and drum give equally long life. Years of practical service have confirmed this. We have always considered impact strength of utmost importance in wheel and hub assemblies, and such routine tests are made. Cast-steel hubs are just as good as forged ones; tests below zero, as well as at room temperature, prove this.

"Considerable savings in cost of production resulted from the adoption of the new alloy for crankshafts, and their actual use has been very successful. The new cast shaft, when finished, weighs about 10 per cent less than the forged shaft.... The amount of metal removed from the forging was 17 pounds, as against 9 pounds for the casting, a decided saving in itself. Since September, 1933 [until the middle of 1936] over 2,000,000 cast shafts have been produced and assembled.... The ability to distribute weight advantageously results in a cast shaft of lower weight than the forging. In the first place, the shaft may be properly counterweighted without having to fasten on separate pieces to balance the part dynamically, as well as statically. The shafts may be ribbed at locations where stresses are highest, with consequent improvement in 'fatigue life.' The shafts may be economically cored out, lightening the pins and enabling metal to be so distributed about the shaft center as to make it actually stiffer than a forging, while being even lighter."

Fig. 1 shows a group of castings designed for use as hubs on truck wheels, which are assembled and fabricated by a combination of welding, machining, and bolting. Fig. 2 represents the main castings of a highway trailer "fifth wheel." It also shows how a good design with ribs placed where needed is available in light weight when using cast steel.

Among the dozens of automotive parts now commonly produced in the steel foundry may be mentioned axle housings and pads; bell housings; brake drums; connecting-rods; starting cranks; crankshafts; equalizer beams; hubs; shock-absorber parts; spring brackets; guards and hangers; shifting forks; and universal joint parts.

Briefly, the advantages claimed for steel castings may be summarized as follows: Steel castings allow the engineer-designer to place his metal judiciously, so as to provide the required strength to meet the service stresses.

A wide range of physical properties can be obtained in ordinary carbon steel castings by means of different heat-treatments to suit the required ductility, tensile strength, impact strength, etc.

The cast steel can be alloyed so as to augment the range of physical properties of the metal. Through alloying and heat-treatments, tensile strengths ranging all the way from 60,000 to 200,000 pounds per square inch can be obtained.

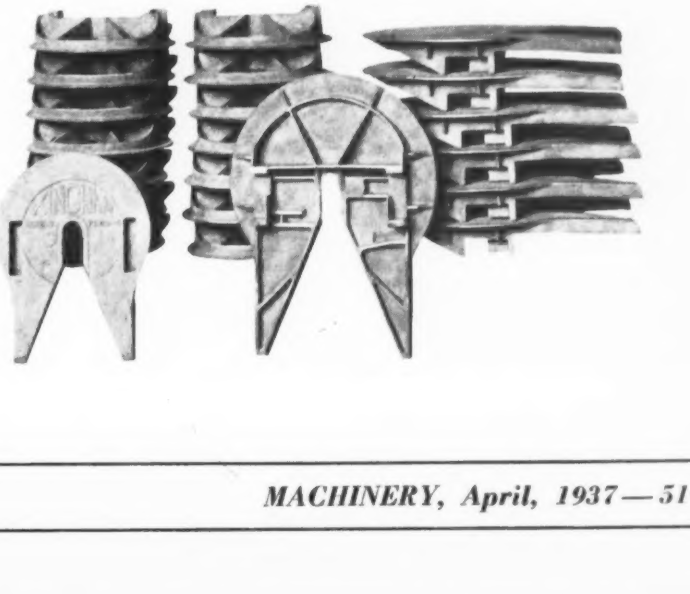
Steel castings are rigid, yet sufficiently elastic (contrary to the impression of many mechanical men) to bend or yield before they break. Ordinary cast steel is not brittle. It is tough. In tests, it can usually be bent double without a break showing on the outer bend surface.

Cast steel can be machined with approximately the same ease as rolled and forged steel. It can be readily combined with other castings or joined to rolled steel by welding. Unmachined steel castings can be furnished with smooth surfaces.

After being heat-treated (practically all steel castings today are at least annealed or normalized and drawn) any residual strains set up in the cooling of the steel casting are relieved, producing a metal of excellent uniformity and strength.

That these advantages are being recognized is evidenced by the fact that there has been a 400 per cent increase in the output of commercial steel foundries during the last twenty months.

*Fig. 2. Main Castings of Highway Trailer "Fifth Wheels." Note the Generous Ribbing which Imparts Strength and Rigidity*



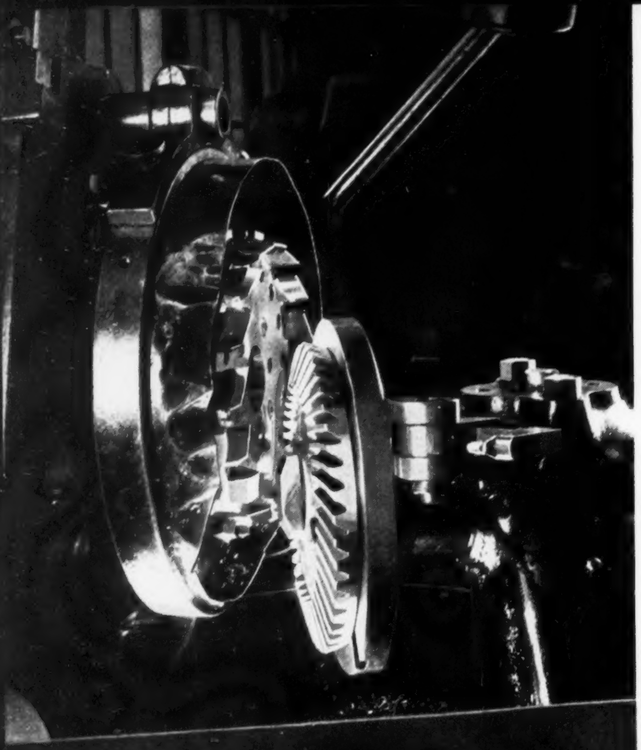


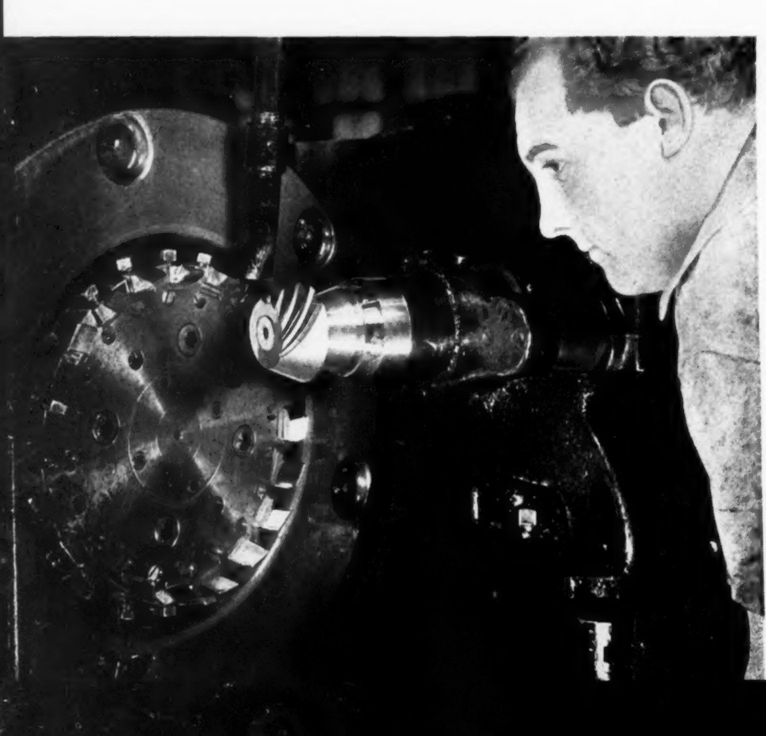
Fig. 1. Finish-cutting a Hypoid-tooth Ring Gear with a Circular Cutter Provided with Staggered Blades that Successively Cut on the Inside and Outside of Adjacent Teeth

# Packard Practice in

*An Outline of the Manufacturing Methods Used by an Automobile Company that Adopted Hypoid Gears Eleven Years Ago*

By CHARLES O. HERB

Fig. 2. Hypoid-tooth Drive-pinions are Rough-cut in One Operation and Then Finished in Two Operations, in which Cuts are Taken on Opposite Sides of the Teeth



HYPOID gears have been used continuously since 1926 by the Packard Motor Car Co., Detroit, Mich., for driving the rear-axle shafts of automobiles, although they did not come into wide general use by other manufacturers until recently. Hypoid gears were adopted by Packard engineers because they were found to be even stronger and quieter than spiral-bevel gears, which were then in general use for the same application. The advantage of hypoid gears in permitting the position of the drive-shaft of automobiles to be lowered with respect to the center of the wheels did not become important until the advent of the low-built cars of late years.

In the manufacture of hypoid gears and pinions, the Packard Motor Car Co. uses exclusively the line of roughing and finishing gear-tooth cutters, quenching presses, lapping machines, matching machines, and inspection equipment developed by the Gleason Works, Rochester, N. Y. This article will outline the manufacturing procedure.

Hypoid teeth are cut on Packard drive-pinions and ring gears by using the rotary type of inserted-blade cutter commonly employed in cutting spiral-bevel teeth, the generating principle being the same. This cutter is carried in a rotating cradle and has considerable angular adjustment to suit the spiral angle of the teeth being cut. A hypoid-tooth roughing operation on a drive-pinion is illustrated in Fig. 2, while a finishing operation on a hypoid-tooth ring gear is shown in Fig. 1. It will be seen that the pinion is above the axis of the cutter, but it is below the axis of the imaginary generating gear of which the cutter represents a tooth. On the other hand, the ring gear is below the center of the cutter and therefore above the axis of the imaginary generating gear.

The roughing operation on both pinions and ring gears cuts the hypoid teeth to the proper path and form, leaving from 0.010 to 0.015 inch of stock on

# Cutting Hypoid Gears

each side of the teeth for removal in the finishing operations. Two finishing operations are necessary on the drive-pinions because of the fact that the rotary finishing cutters used for pinions are made with all the blades cutting either on the inside or on the outside of the teeth. Thus, one side of all the teeth is cut in the first finishing operation, and the opposite side of the teeth in the second finishing operation.

One of the interesting differences between spiral-bevel and hypoid gears that is important in the finishing operations is that, whereas the profile of spiral-bevel teeth is symmetrical on both sides, the profile of hypoid teeth is non-symmetrical on the two sides. This difference in the profile on the opposite sides of the teeth is much more pronounced on pinions than on gears, and it is for this reason, that two finishing operations are performed on pinions. The operating principle of the finishing machines is similar to that of the roughers.

The ring gear teeth are finished in one operation by the use of the conventional type of rotary cutter on which inside and outside cutting blades are staggered, so that one cutter blade finishes one side of a tooth and the succeeding blade finishes the opposite side of the adjacent tooth.

Packard driving gears are produced in four different ratios to suit various sections of the country to which the automobiles are shipped. These ratios are 10 to 47, 11 to 45, 11 to 48, and 11 to 50. On the 10-tooth pinion, the spiral angle is 49 degrees 52 minutes, while the spiral angle of its mating 47-tooth gear is 25 degrees 57 minutes. The spiral angles of the pinion and gear in the 11 to 45 ratio are 50 degrees 8 minutes, and 26 degrees 37 minutes, respectively. The spiral angles of the pinions and gears in the other two ratios are between those extremes. The diametral pitch of the pinions and gears in the complete series varies from 4.737 to 5.263.

One of the important requirements of the ring gears as they come from the finishing machines is that the tooth spacing must be accurate within 0.0007 inch. Every day one of the gears produced by each machine is checked for tooth spacing by means of the Zeiss Optimeter shown in Fig. 4, and this inspection is also performed each time that a machine is set up.

This inspection device has a swinging arm, on which is mounted a tube that carries an Optimeter

*Fig. 3. The Inside and Outside Ends of the Ring Gear Teeth are Chamfered in a Machine that Operates on the Shaper Principle and is Equipped with an Indexing Table*

*Fig. 4. The Ring Gears Produced by Each Finishing Machine are Inspected Every Day for Accuracy of the Tooth Spacing by the Optical Instrument Here Illustrated*

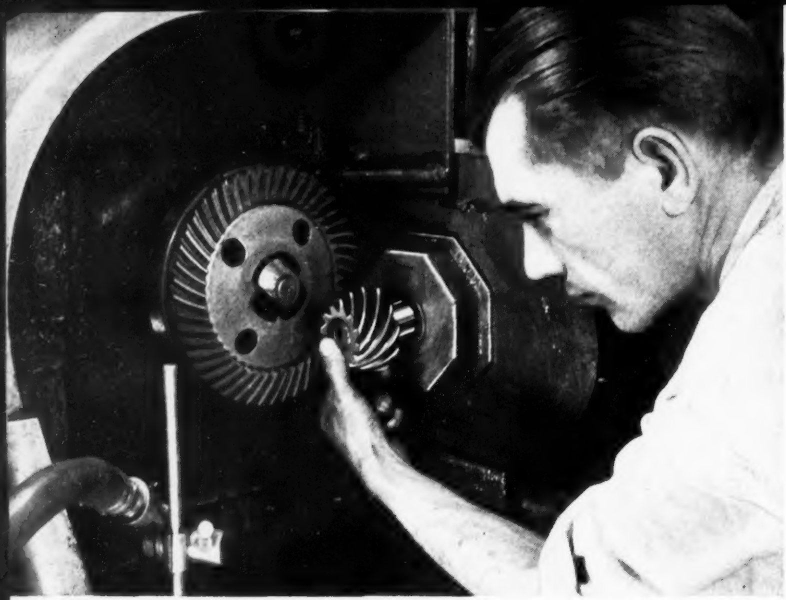


*Fig. 5. Selected Pinions and Ring Gears are Lapped after Heat-treatment by Running in Mesh for Ten Minutes during which a Fine Abrasive Compound is Pumped to the Revolving Parts*

and two fingers that contact with the same side of successive gear teeth. One finger is pivoted in the center and operates against a graduated scale within the tube, thus indicating any differences in tooth spacing. When observed through the eye-piece of the instrument, the graduations of the scale within the tube appear about 1/16 inch apart—they represent variations of 0.00005 inch.

A gear to be inspected is set up on a surface plate as shown, and indexed to bring all the teeth successively to the space-checking fingers of the Optimeter. Each time that a gear is to be indexed, the contacting fingers are raised by imparting a quarter turn to a handle on the end of the swinging arm.

Ring gears are also checked periodically for smoothness of tooth action as they come from the finishing machines, so as to insure a good lapping condition after heat-treatment. This checking is made by rolling a ring gear in mesh with a master pinion, the teeth of the ring gear being first painted with red lead so that the nature of the contact between the master pinion and the gear can be readily observed.

The teeth of ring gears are chamfered at both ends by a machine of special design, which is shown in Fig. 3. This machine is equipped with an indexing table that can be tilted for chamfering the teeth at either the inner or outer end. The cuts are taken by a tool mounted on a horizontally reciprocating ram, the table being indexed with each stroke of the ram to bring the successive teeth into line with the tool. Burrs on the ends of the pinion teeth are removed in a simple filing operation.

Ring gears are next ground on the edge or back cone in an operation in which they are located from the previously ground bore. This operation is performed merely to insure an accurate surface for locating purposes in regrinding the bore after the heat-treatment. In the regrinding operation, the tops of the teeth are also used for locating purposes. Then the trademark of the company, the piece number of the gear and the date of manufacture are all stamped on the gears by means of a marking machine.

The ring gears and pinions are next placed on hook type conveyors, which carry them to the heat-treating department on the floor below. Here they are loaded on grille type trays and carried through pusher type furnaces, in which they are carburized in natural gas. The pinions are loaded on trays with the shaft ends downward, while the ring gears are stacked seven high on top of each other with spacers between. The furnaces are maintained at a temperature of 1675 degrees F. and the parts are held in them for ten hours. Each furnace is 33 feet long inside. Natural gas is used for fuel and also for the carburizing medium. One of the important advantages of carburizing by this method is cleanliness, as the work does not need to be cleaned at the end of the heat-treatment. Also, the process has been found to be much faster than other methods.

When the pinions reach the far end of the carburizing furnace, they are automatically discharged into an oil quench through an enclosed chute that leads from the bottom of the furnace to the quenching tank beneath. With this arrangement, the heated pinions are not affected by the room atmosphere. The oil bath is maintained at a temperature of between 100 and 110 degrees F. Both furnaces were built by Holcroft & Co., Detroit, Mich.

The ring gears are individually quenched in a Gleason press of the standard type, in which the gear is clamped between upper and lower dies that hold it flat during the cooling period and still permit it to contract freely. The gear is submerged in oil during this process, oil being forced through the teeth at a high velocity. Each gear remains in the press about two minutes, during which time a pressure of 5000 pounds is applied to hold it straight. When taken from the press, the back surface of the gears must be straight within 0.003 inch.

The heat-treatment leaves the pinions and gears with a case depth of from 0.040 to 0.045 inch. The parts are checked 100 per cent for hardness and must be file hard. The pinion and ring gears are then returned to the machining department on the same conveyors that took them to the heat-treating department. Here the shanks of the pinions are checked to make sure that the run-out does not exceed 0.001 inch, after which two bearing surfaces and splines are ground on the shanks. The bore of the ring gears is also ground, as already explained.

From these grinding operations, the pinions and ring gears go to a matching machine where pairs are selected according to tooth bearing conditions. The selected pairs are then carried by the overhead conveyor to lapping machines, where they are run together for ten minutes. During this operation, a compound consisting of FFF carborundum powder suspended in machine oil is constantly pumped to the rotating parts. Fig. 5 shows an operator loading a gear and pinion into a machine for the lapping operation.

At the beginning of this operation, the ring gear and pinion are set up with a backlash of about 0.008 inch. This is reduced to about 0.003 inch during the operation by adjusting the pinion closer to the gear. Power is transmitted through the pinion which runs at a speed of 1050 revolutions per minute, first in one direction for four minutes then in the reverse direction for four minutes, again in the first direction for another minute and finally in the reverse direction for one minute. During each of the four-minute periods the ring gear is oscillated up and down about 0.010 inch, so as to insure full contact of the teeth from the heel to the toe, but during the one-minute periods the ring gear is rotated without oscillation.

Each lapped pair of ring gears and pinions is given a final test for quietness of operation and tooth bearing in machines of the type shown in Fig. 6, which are installed in a silent room. The operators of these machines also determine the distance from a shoulder on the pinion shank to the center of the mating ring gear, a tolerance of plus or minus 0.001 inch being specified for that dimension. The inspector designates the amount of stock that must be ground from the pinion shoulder to meet this requirement. The dimension is important, because the pinion is located in the rear-axle carrier from that shoulder without the use of shims.

The teeth of the gear and pinion are painted with red lead at the beginning of this inspection, and by observing the shading of the red lead at the end of the operation, the inspector can determine the correctness of the tooth bearing condition. The inspection machines are completely hydraulic. After a ring gear has been slipped on the faceplate and a pinion shank inserted into the spindle of the driving head, the inspector merely moves a lever to clamp both working pieces by hydraulic means. Also, the relative positions of the ring gear and pinion can be changed hydraulically.

To start these machines and keep them in operation, the inspector must depress a button on each end of the machine and hold it depressed, which guards against his fingers getting caught between the fast running gears. The pinion is driven at a speed of 1050 revolutions per minute, as in the lapping operation.

The average worker on the payrolls of the automobile manufacturers in Detroit could buy more of the comforts of life with his wages in 1936 than in any previous year in automobile history. This fact is based upon a study of the average cash earnings in 1936 and the living costs in Detroit. While the average cash earnings, expressed in dollars, were reduced about 7.5 per cent from 1929, the living costs were reduced 20 per cent; thus the purchasing power was increased about 13 per cent.

*Fig. 6. Final Inspection of the Drive Gears for Quietness of Operation, Tooth Bearing Conditions, and Distance from a Shoulder on the Pinion Shank to the Center of the Mating Ring Gear*

# *Forty Cuts Taken on Connecting-Rods and Caps*

FORTY drilling, chamfering, reaming, and milling cuts are taken simultaneously on fourteen connecting-rods and their caps by a machine recently built by Greenlee Bros. & Co., Rockford, Ill., for the Packard Motor Car Co. This machine is equipped with an eight-station turret which is indexed by hand to bring the connecting-rods into line with the successive tools. Two connecting-rods and their caps are placed in each of the fixtures, the loading station being at the front of the machine. The production is 200 rods and caps per hour.

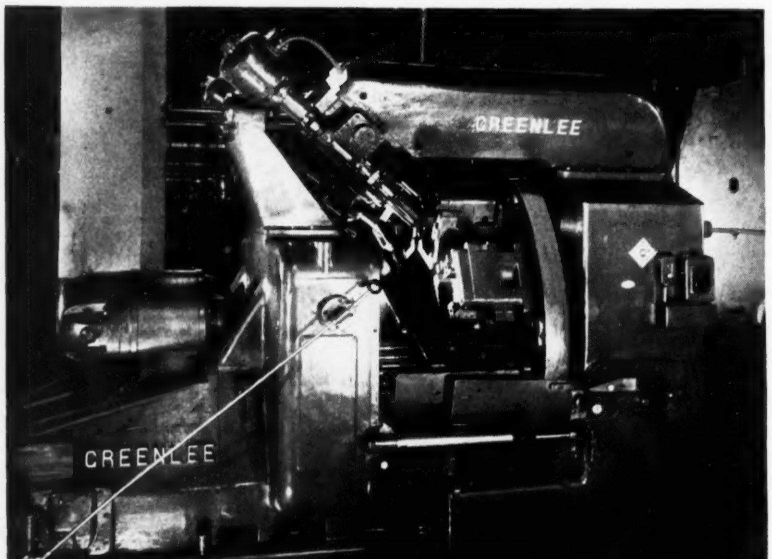
Most of the cuts are taken by tools on a multiple-spindle head, mounted on a hydraulically actuated slide which moves horizontally on the base of the machine. This head is also equipped with an attachment on which there are two arbors provided with two cutters each, for milling locking slots on the connecting-rods and caps. In addition, there are two self-contained units mounted in angular positions on top of the machine for performing operations on parts at the seventh and eighth stations. Each unit is equipped with two drill spindles.

The turret is indexed by turning a crank-handle, and it is mounted on large ball bearings. Safety devices prevent double or reverse indexing; however, the safety device can be released when it is necessary to turn the turret backward.

At the second station of the turret, 23/64-inch bolt holes are drilled half way through the connecting-rods and caps, and at the third station, the drilling of these holes is completed. The holes are next chamfered on the joint faces at the fourth station, and they are reamed to 0.377 inch at the fifth station. A slot 0.160 inch wide is milled in the bearing surface of each connecting-rod and cap for locking purposes at the sixth station. All these tools—a total of thirty-six—are mounted on the multiple-spindle head of the horizontal slide and on the milling attachment which it carries.

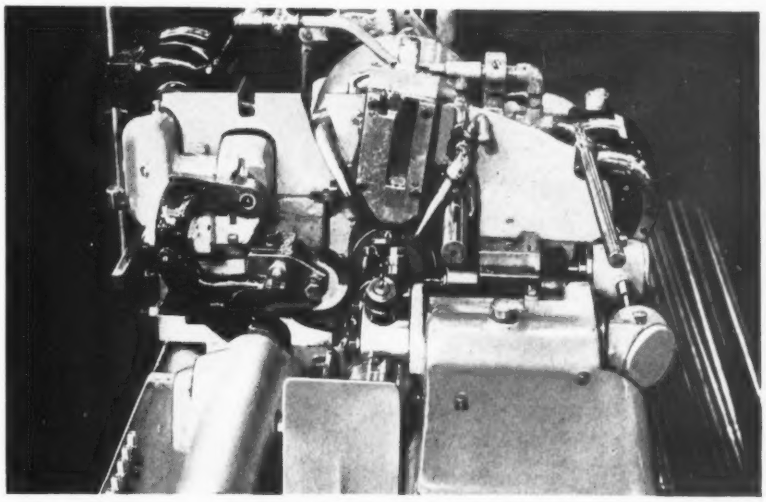
At the seventh station, a small hole is drilled half way through the section of each connecting-rod that joins the arm with the bearing end, and at the eighth station, this hole is completed.

Guide bushings for all the tools of the horizontal multiple-spindle head are carried in a sliding plate which registers in the turret with each advancing movement of the head. This plate locks the turret rigidly in the proper relation to the head. Hydraulic feeding of the main slide is effected by means of a pump, cylinder, and control valves in the base. Adjustable dogs provide for obtaining the desired rapid approach, feed movement, and rapid return. All machine movements, with the exception of starting, are performed automatically.

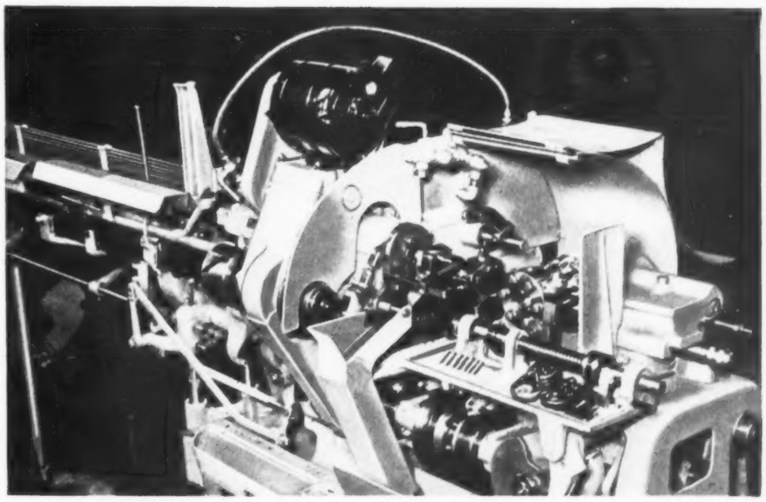



*High-production Machine that Performs Forty Operations on Fourteen Packard Connecting-rods and Their Caps at One Time*

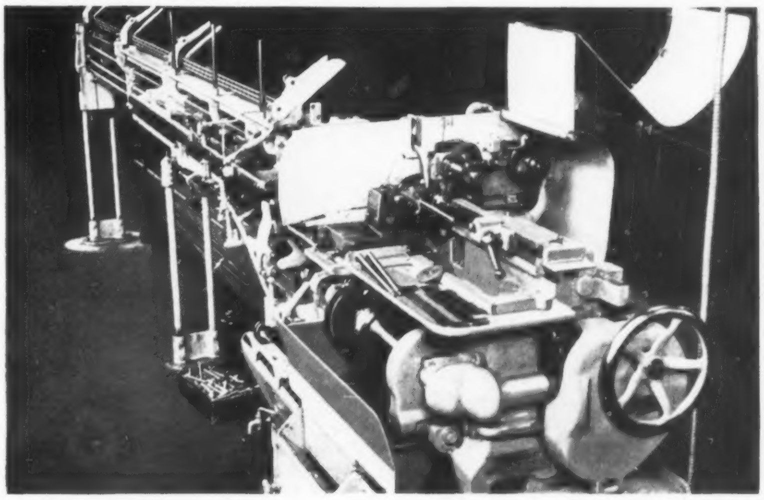
# *Automatics with New Features*



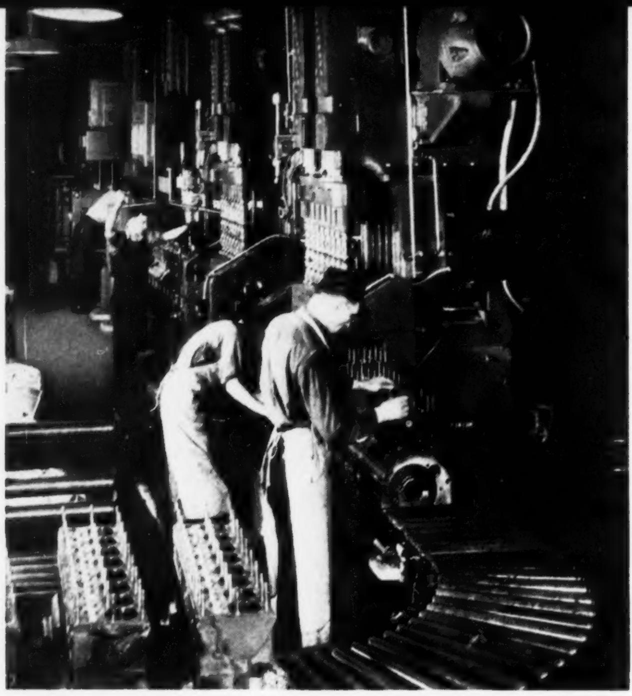
*Special Drilling and Cross-drilling Attachments Driven from a Single Motor, Enable This Brown & Sharpe Motor-driven High-speed Automatic to Produce Brake Adjustment Screws without Secondary Operations. The Operation Consists of Drilling, Forming, Cross-drilling, Removing the Burr from the Cross Hole by a Drill on the Turret, Threading, Cutting off and Removing the Cut-off Burr by a Screw Slotting Attachment*



*An Automatic Magazine on This Brown & Sharpe Motor-driven High-speed Automatic Screw Machine Brings Successive Rods of Stock into Line with the Machine Spindle as the Preceding Rods are Used up. A Rear End Threading Attachment Enables the Machine to Produce Studs which are Threaded and Chamfered on Both Ends. Three Additional Handlings of the Work were Performed before This Type of Machine was Installed, as Five Operations were Required*



*Automobile Push-rods are Formed and Cut off in This Brown & Sharpe Motor-driven High-speed Automatic, Equipped with a Roller Feed and Timing Mechanism and a 12-foot Automatic Rod Magazine. Stock for Each Piece is Fed Beyond the Collet in Less than One Second; on the Automatic Previously Used, Four Feed-cuts were Required, Each Consuming One Second. The Automatic Rod Magazine has also Increased the Efficiency of the Present Machine*

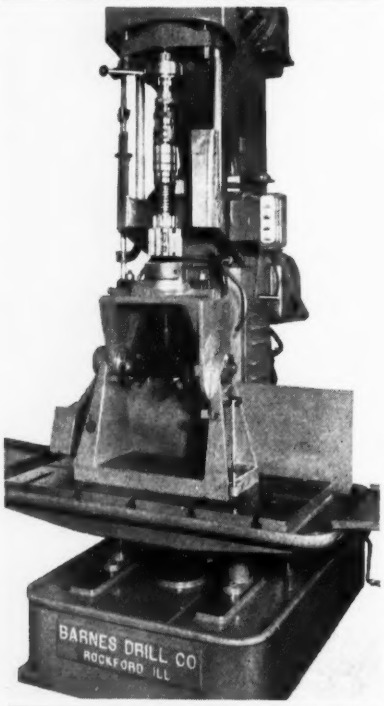


# *Honing—Universal for Combustion*

*This Method Has Become the Last Word in Refinement for Finishing Engine Cylinders of Various Types and Sizes*

*Fig. 1. Automobile Cylinder Bores are Finished all over the World by Honing. This Illustration Shows Two Machines Honing Straight-eight Cylinder Blocks*

*Fig. 2. The Steel Sleeve in this Airplane Engine Cylinder is Mirror-honed to a Diameter of 4 5/8 Inches within Plus or Minus 0.0004 Inch, and Straight within the Same Tolerance*




TEN years or so ago, a revolutionary change was made in the method of finishing automobile cylinder bores. Previous to that time, the final operation on the cylinder bores consisted either of reaming, internal grinding, or burnishing by means of a tool made up with a series of rollers. None of these methods enabled the attainment of the close accuracy or high finish which the automotive industry considered desirable.

The search for a means of improving the finish of cylinders led to the development of the honing process, which involves the use of an expanding tool provided with relatively long and narrow abrasive stones. By simultaneously reciprocating and rotating this honing tool in a bored and reamed cylinder, it was found that much greater accuracy and a mirror-like finish could be obtained, at much faster rates of production than by the methods then in use.

Within a comparatively short time, honing became the standard method of finishing automobile cylinders in the United States, and today it is universal practice the world over. Honing enables cylinder bores to be finished to within 0.0005 inch of the specified diameter, as well as straight and round within the same tolerance. Such meticulous accuracy is being obtained day in and day out at production rates of nearly 100 eight-cylinder blocks an hour per machine, with one operator.

With this high degree of cylinder finish, and with the lighter honed connecting-rods and other refinements in the fit of working parts, automobile manufacturers no longer find it necessary to warn buyers of new automobiles against fast driving before the cars are "broken in"—new automobiles can now be driven at speeds of fifty miles or more an hour as soon as they leave the factory without danger of damage to the engine. The most important advantage of honing, however, lies in the greater efficiency of the engine. Piston-rings and

# Finishing Method Engine Cylinders

By JOHN E. ANDRESS
President, Barnes Drill Co.
Rockford, Ill.

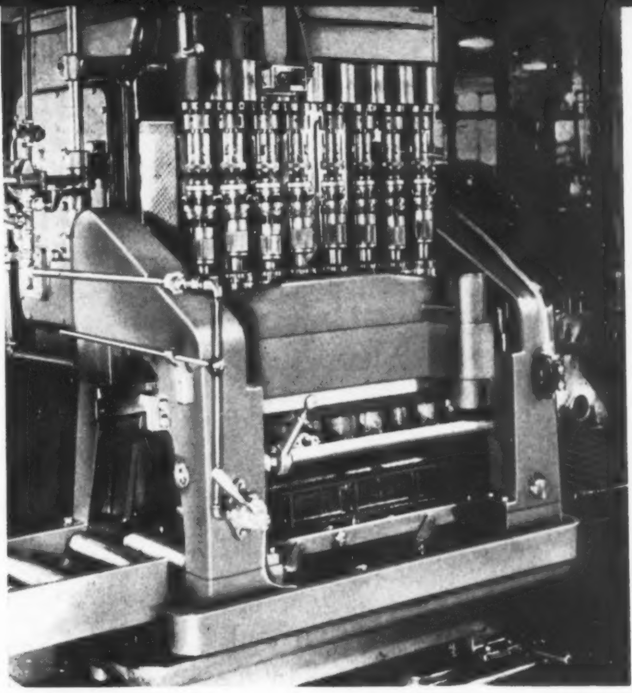


*Fig. 3. Close-up View of One of the Machines Illustrated in Fig. 1, Showing Eight Cylinder Bores being Honed Simultaneously in an Automobile Engine Block*

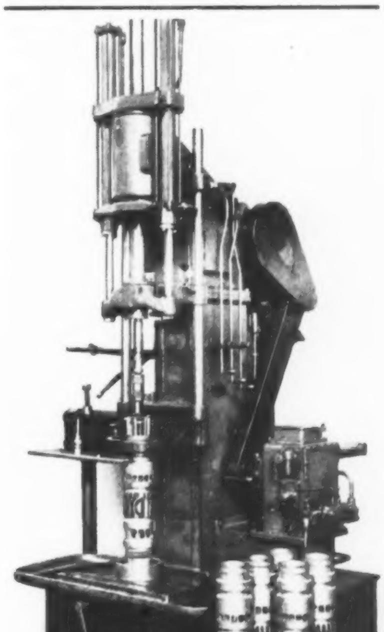
pistons can be fitted more closely, thus increasing the compression and power of the engine, and giving greater mileage per gallon of gasoline. The durability of pistons and rings in mirror-honed cylinders is decidedly increased. The general practice in automobile plants is to remove approximately 0.002 to 0.003 inch of stock on the diameter of cylinder bores by rough-honing. Then a secondary honing operation, in a very few cycles, removes a minute amount of stock and produces the mirror-like smoothness and high accuracy.

### *The Spread of Honing Outside the Automobile Industry*

The complete success of honing in finishing engine cylinders for automobiles naturally led to the application of this method to cylinders of other types of internal-combustion engines. The Barnes Drill Co., Rockford, Ill., was a pioneer in building honing machines, not only for automobile plants, but also for shops engaged in the manufacture of motor trucks, tractors, airplanes, and Diesel engines. It must not be assumed that honing is limited to cylinders, because it is being employed at the present time for finishing many other parts. However, the scope of this article is confined to cylinders. The honing machines shown are built by the Barnes Drill Co. and are equipped with hones made by the Micromatic Hone Corporation, Detroit, Mich.

Two machines installed at the Packard Motor Car Co.'s plant for honing cylinder blocks for the "120" medium-priced automobile, introduced on the market last year, are seen in Fig. 1. Fig. 3 shows a close-up view of one of the machines. Eight bores are honed simultaneously by the multiple-spindle heads of these machines. One of the machines rough-hones each cylinder block, and the other mirror-finish hones them. The multiple-

*Fig. 4. Honing Diesel-engine Cylinder Liners of the Opposed-piston Type. These Liners Measure 5 Inches Inside Diameter and 36 Inches Long. The Bores must be Straight within 0.001 Inch*



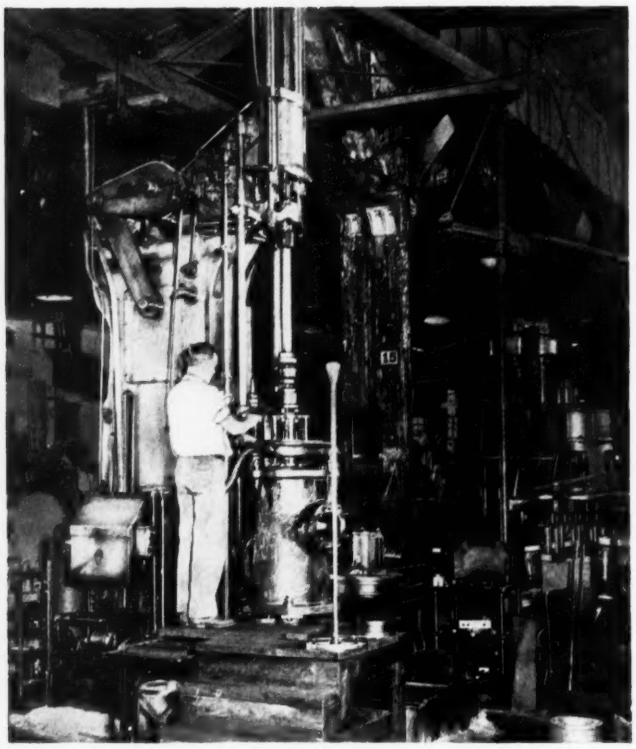


*Fig. 5. The Honing Process has also been Adopted for Finishing Cylinders of Diesel Engines. This Illustration Shows a Cylinder 14 Inches in Diameter by 54 Inches Long which is Honed within a Floor-to-floor Time of Ten Minutes*

spindle head of both machines is reciprocated up and down by two hydraulically actuated rams. This type of multiple-cylinder honing machine is generally used by the leading automobile engine builders throughout the world.

The bores of these cylinder blocks are honed to a diameter of 3 1/4 inches, plus or minus 0.0005 inch, and are 7 1/2 inches long. In rough-honing, the average production is 43 cylinder blocks an hour, and in finish-honing, 46 blocks an hour.

### *In Honing Airplane Engine Cylinders, Tools Suitable for Blind Holes are Necessary*

Cylinders for airplane engines are honed after the sleeves have been assembled in the heads, and consequently the hone operates in a blind hole. On this account, the machine is so arranged that the hone can be made to dwell at the bottom of the bore for a variable number of revolutions. This is controlled by a hydraulic valve. At the end of the predetermined dwell, the reciprocating movement is automatically resumed.

Fig. 2 shows equipment employed in a number of plants for this operation. The cylinder head is mounted in a trunnion type fixture which tips over for reloading, so as to bring the cylinder head upward. Four studs in the fixture fit the holes in the flange of the cylinder head and nuts are used to fasten the head to the top plate of the fixture. A pull-pin automatically locks the fixture when it is swung upward into the working position, when it is in the loading position, and also when it is in a horizontal position for gaging.

The hone is guided in a bushing provided in an adapter plate attached to the top of the fixture. Coolant is fed directly to the cylinder through two removable flexible hose and bushings. These hose are disconnected when the fixture is turned over for reloading. Honing is performed in the usual way by combined rotating and reciprocating movements. Arrangements are also made for using cast-iron laps after honing with the abrasive stones. In lapping, the rotary drive to the spindle is disengaged, but the reciprocations continue. At the end of each lapping cycle, the operator moves the spindle clockwise slightly by means of a hand indexing ratchet on the spindle, so that the cast-iron laps produce a straight-line, satin finish.

Equipment of this type is used on cylinders of various diameters up to 6 1/4 inches. The cylinder sleeve shown being honed in Fig. 2 is 4 5/8 inches in diameter by 8 inches long. It is honed to size within 0.0004 inch, and then straight-line lapped to remove "cross-hatch" and to obtain a satin finish. Machines of this type, provided with a lateral indexing type of fixture, are also being used for honing the cylinder sleeves of straight-line water- and Prestone-cooled cylinder blocks in which steel liners are used.

### *Diesel-Engine Cylinders up to 20 Inches in Diameter are Finished by Honing*

Honing machines have been built by the Barnes Drill Co. for finishing bores up to 20 inches in diameter, thus providing equipment that meets the needs of Diesel-engine builders. In the operation shown in Fig. 5, a cylinder 14 inches in diameter by 54 inches long is being honed to size within plus or minus 0.001 inch (the customer's tolerance). The honing is performed over several port holes. The average honing time is 10 minutes, floor to floor.

The body of the hone used in this operation is made of heavy construction, so as to give a steadying influence. When a long cylinder like this has

a slight taper, the hydraulic honing machine can instantly be made to hone the small end of the bore with *short strokes* until the taper has been removed, whereupon the spindle automatically resumes its normal working stroke.

Cylinder liners 36 inches long, with a hole 5 inches in diameter, are honed in the machine shown in Fig. 4. These cylinder liners are used in Diesel engines, opposed pistons operating in the opposite ends of the cylinders. One of the features of this operation is the large number of port holes over which the hone must pass. By a special arrangement, the surfaces adjacent to these port holes are honed over size from 0.004 to 0.005 inch. These long sleeves must be honed to size within plus or minus 0.001 inch.

### *Honing Speeds Depend upon the Material*

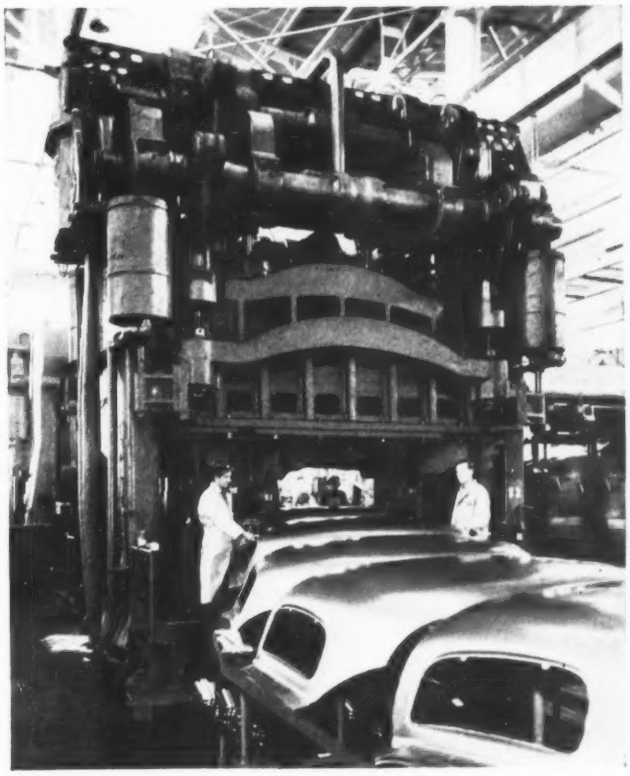
In honing cast iron, the hone may be run at peripheral speeds ranging from 200 to 250 feet a minute, while in honing steel, speeds from 150 to 200 feet a minute should be used. Likewise, with cast iron, the hone may be reciprocated at any rate between 50 and 75 lineal feet a minute, whereas in honing steel the rate of reciprocation should be about 40 feet a minute.

The correct synchronization of rotary and reciprocating speeds depends upon the diameter of the bore, the kind of metal being honed, and the amount of stock to be removed by honing. Generally speaking, the included angle between the helix of strokes aimed in opposite directions should be between 40 and 60 degrees.

The amount of stock removed by honing depends also upon the material. The ordinary practice is to hone from 0.0007 to 0.004 inch of stock from holes 1 to 5 inches in diameter in cast-iron parts; from 0.003 to 0.0065 inch from holes 6 to 11 inches in diameter, inclusive; and from 0.005 to 0.008 inch from holes 12 to 20 inches in diameter, inclusive. In honing holes in steel parts, the practice is to remove from 0.0003 to 0.0015 inch of stock from holes 1 to 5 inches in diameter, and 0.001 to 0.002 inch of stock from holes 6 to 11 inches in diameter. In each instance, the figure indicating the amount of stock removed means the bore diameter.

Honing in "tenths" is now an accomplishment in many small classes of work, including tapered bearing cups and roller-bearing raceways.

*All-steel Turret Tops for Fisher Automobile Bodies Issue in an Unending Stream from a Battery of Giant Presses in the Recently Opened Grand Rapids Stamping Division Plant of the General Motors Corporation. The Tops are Drawn and Formed Under a Pressure of 5200 Tons*



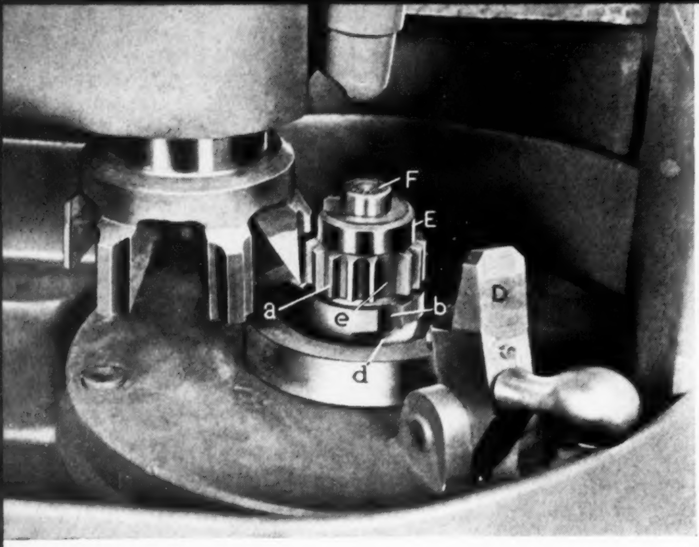



*Fig. 1. Cutting the Slots in Automobile Clutch Gears by Employing a Special Six-prong Cutter in a Fellows High-speed Gear Shaper*

# Automatic Slotting

AUTOMOBILE clutch gears of the type seen at *a* in Fig. 1 are made with three involute-sided slots *b* that must be cut after the gear teeth and the slots *e* which separate the teeth into three groups. The gear teeth and slots *e* are produced in a Fellows high-speed gear shaper provided with a special cutter that finishes the teeth and the slots, which also have involute sides, at one setting of the work.

Slots *b* are then also cut in a Fellows high-speed gear shaper, as shown in Fig. 1, after first milling three semicircular grooves *d* in the gear blank to provide clearance for the cutter. The special cutter used in this operation has six prongs or teeth which are ground to the same shape as the finished slots. Only one tooth of this cutter is used in an operation. As each tooth becomes dull, the cutter is indexed 60 degrees to bring a sharp tooth into position. This is repeated until all six teeth are dull, after which the cutter is removed from the machine and resharpened.

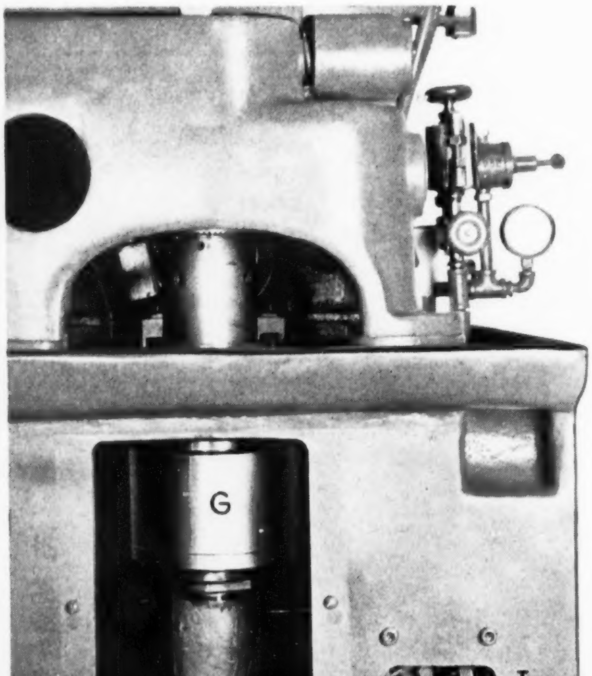
To index the successive cutter teeth into the operating position, nut *A*, Fig. 2, on the upper worm-shaft of the machine is released, so as to separate the members of the face clutch *B*. A crank-handle is then applied to the upper worm-shaft *C* to revolve the cutter through 60 degrees. This requires 15 revolutions of the worm-shaft. Nut *A* is then tightened to re-engage the clutch.

The work is set in relation to the cutter by entering the gage-pawl *D*, Fig. 1, into one of slots *e* in the work. As soon as the gage-pawl is released, it springs back into its original position. The work is held on a stub arbor by means of a slotted collar *E* and a draw-rod *F*, the latter being actuated by air cylinder *G*, Fig. 3, through foot-pedals *H* and *I*.

Cutting and indexing of the work are accomplished automatically by electrically controlled mechanisms. Once the machine has been set up for a job, the operator starts it by depressing button *K*, Figs. 2 and 4. This energizes the main motor *L*, causing feed-cam *M*, Fig. 4, to advance the cutter toward the work and also to reciprocate the cutter. When the cutter reaches the full depth of the cut, the roll that runs on the feed-cam drops into a depression in the periphery of the cam and allows the saddle to be returned for withdrawing the cutter from the work.

The depth feed switch *N*, Fig. 2, then makes contact at *O*, Fig. 4, energizing a plunger solenoid *P*

*Fig. 3. Front View of the Machine, Showing the Air Cylinder which Clamps the Work Securely for the Operation*



# of Clutch Gears

which withdraws the locking plunger $Q$ from its notch in index-plate $Y$ and closes contact at $R$. This contact energizes torque motor $S$ which indexes the work-spindle through pinion $T$ and the crown gear. After the work-spindle has started to index, cam $V$ causes the rotating cam switch $W$ to open, so that solenoid $P$ is de-energized. When this takes place, spring $X$ causes locking plunger $Q$ to ride on the periphery of the index-plate $Y$ until the work is indexed 120 degrees. Plunger $Q$ then drops into one of the notches in the index-plate and locks the work-spindle ready for the next step.

At the same time that the work-spindle is being indexed, the depth feed cam is rotating and the cutter-spindle reciprocating. However, a safety device prevents the cutter from advancing into the work until after the work-spindle has been completely indexed and locked. In the event that the rotating cam switch $W$ is not reclosed, indicating that the indexing of the work-spindle has not been completed before the depth feed cam starts advancing the cutter toward the work, the operation of the machine will be automatically stopped.

After the depth feed cam $M$ has fed the cutter to its full depth, the third depression on the periphery of the cam is reached and the saddle is withdrawn, closing contact $O$ and indexing the work as previously explained. When the cutter is again fed to the full depth, the automatic stop $A_1$ is operated to stop the machine. This stop is operated by a cam on the rear of the feed worm-wheel shaft. It is timed with the depth feed cam $M$, which comes to rest in the position shown in the diagram, ready for the machine to be loaded with a new piece of work.

Owing to the comparatively short stroke necessary in cutting these formed slots in the clutch gears and to the cutter being so designed that it will stand a heavy feed, this operation can be performed at an unusually rapid rate. About 120 pieces per hour is the average production.

▼ ▼ ▼

The automobile has attained lightness and strength in two ways—first, through simplicity of design, and, second, by the use of high-strength alloy steels. In the present Ford car, something like thirty-six different varieties of specially developed steels are employed.

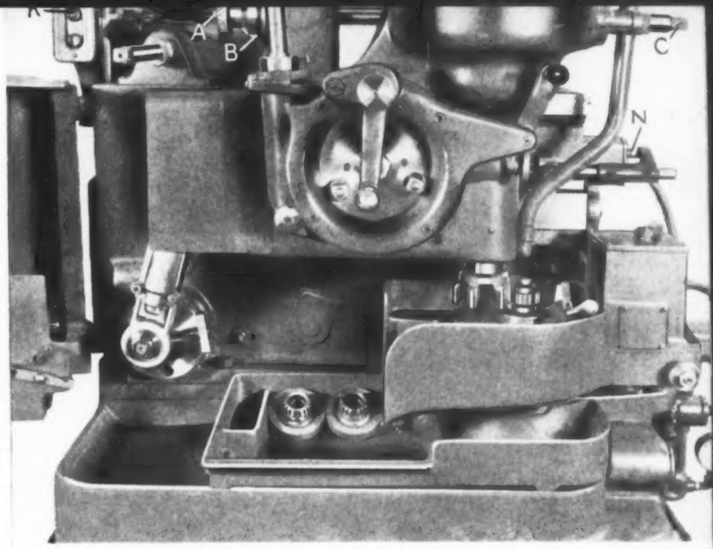
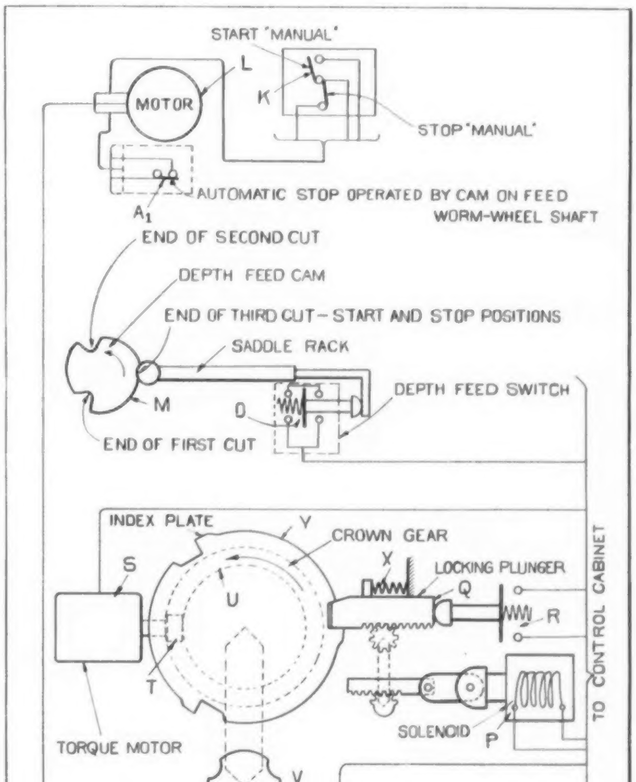
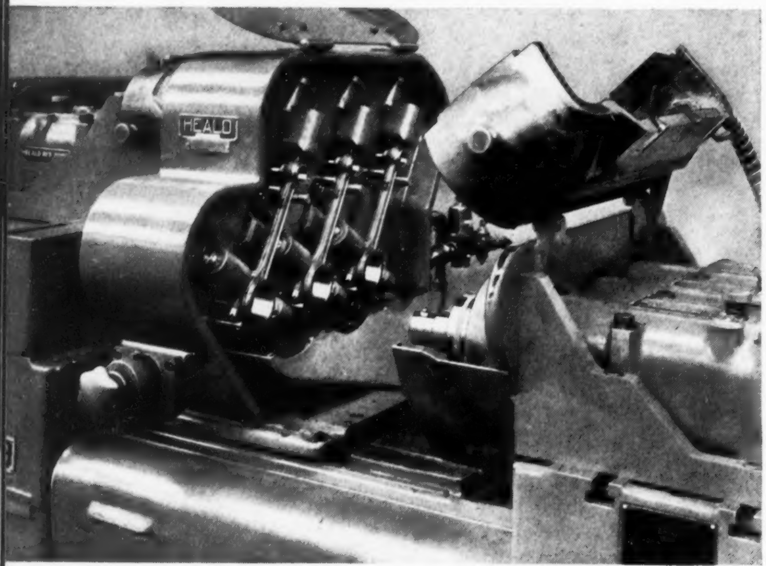



*Fig. 2. Another View of the Gear Shaper Used for Slotting Gears, which is Equipped with an Automatic Electrical Control for the Cutting and Indexing*

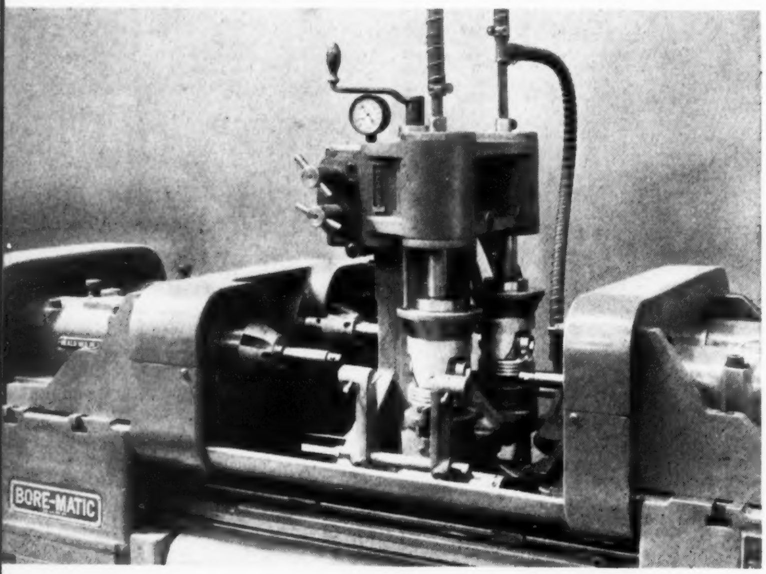
*Fig. 4. Diagram of Electrical Control Provided on the Gear Shaper Used for Slotting Automobile Clutch Gears*



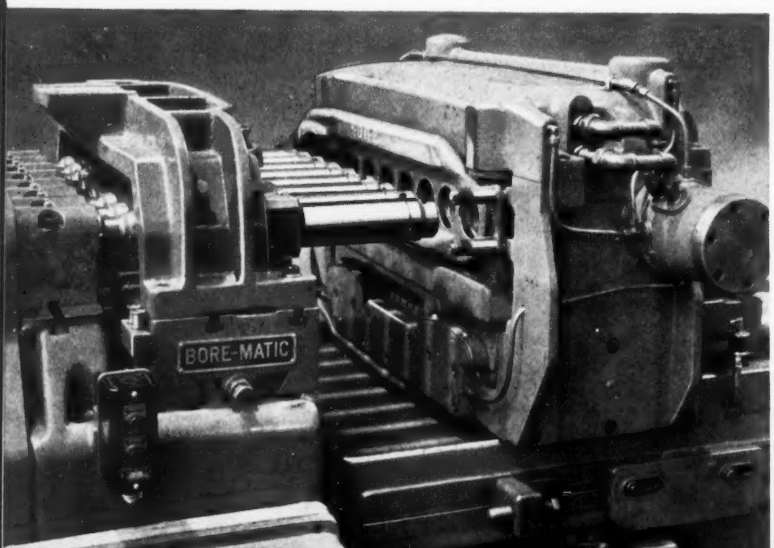
# *Latest Bore-Matic Applications*




*Precision Boring of Automobile Connecting-rods has Become Universal Practice. Various Machine Set-ups have been Devised to Meet Individual Shop Requirements. In the Operation Shown, the Steel of the Crankpin Hole is Bored in Three Connecting-rods at the Same Time that the Bronze-bushed Piston-pin Holes are Bored Parallel in These Rods. The Production is 142 Connecting-rods an Hour*



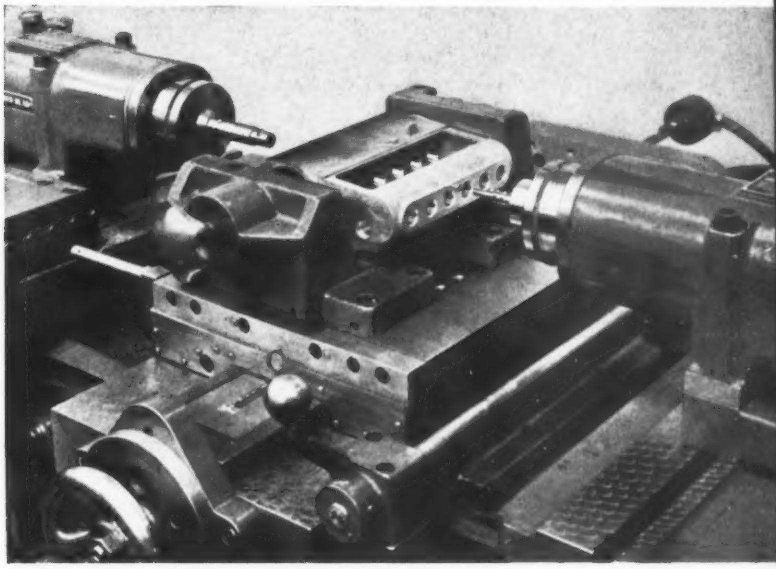

*Boring the Pin-holes in Automobile Pistons was One of the Earliest Applications of the Precision Boring Machine. Here Two Pistons are being Simultaneously Rough-bored and Then Finish-bored to Size within 0.0002 Inch and Straight and Round within 0.0001 Inch by Tool-heads on Opposite Ends of the Machine. The Hydraulic Clamping Device Facilitates Loading. Production, 80 Pistons an Hour*



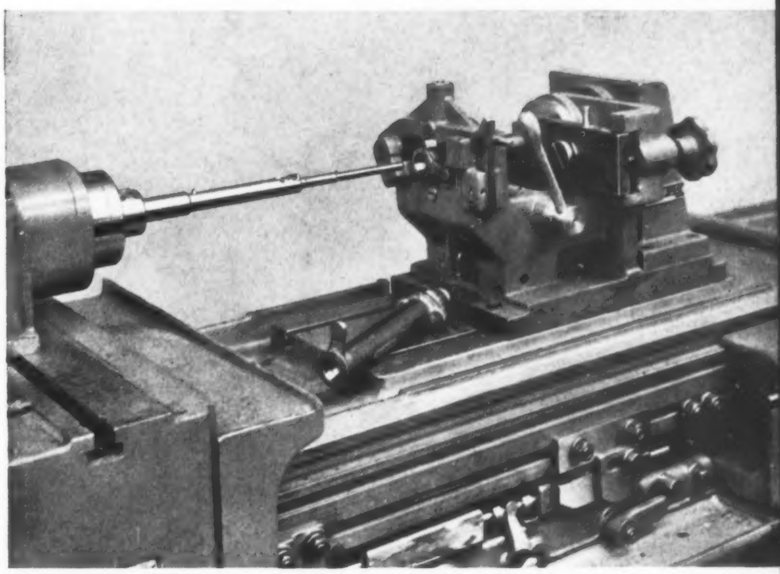

*Precision Boring of Automobile Cylinder Blocks is Now Standard Practice in Many Automobile Plants. In the Operation Illustrated, the Cylinders of a Straight-eight Block are Bored Round, Straight, and Parallel within 0.0002 Inch, and also Square with Respect to the Crankshaft Bearing Holes. The Cylinder Block is Fed Hydraulically to and from the Tools*

# *in Automotive Plants*

*Photographs, Courtesy of*
*HEALD MACHINE CO.*

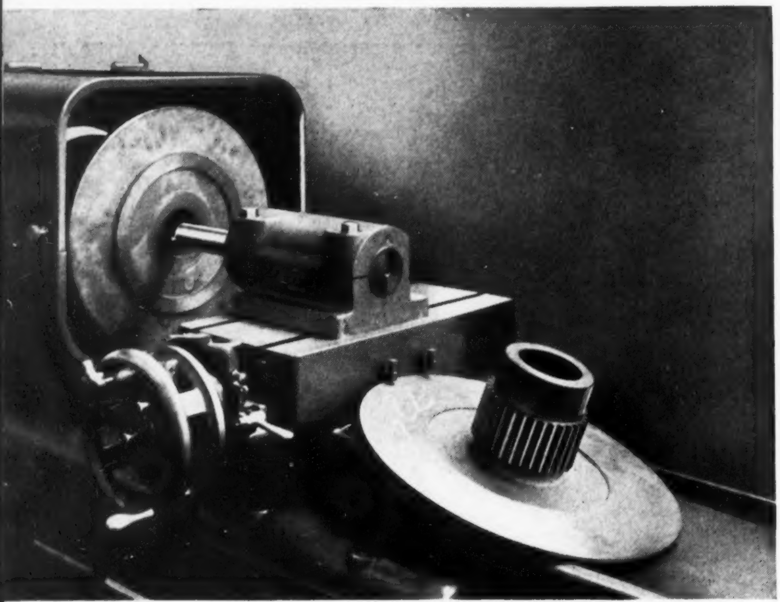


***Boring Aluminum Six-cylinder Fuel Pump Housing for Diesel Engines. The Right-hand Head of the Machine Bores Four Concentric Surfaces in Each of the Holes on that End of the Casting, while the Left-hand Head Bores Three Surfaces in Each Hole on the Opposite Side of the Casting. The Work Fixture is Indexed Crosswise Hydraulically to Align Each Pair of Holes with the Tool-spindles***

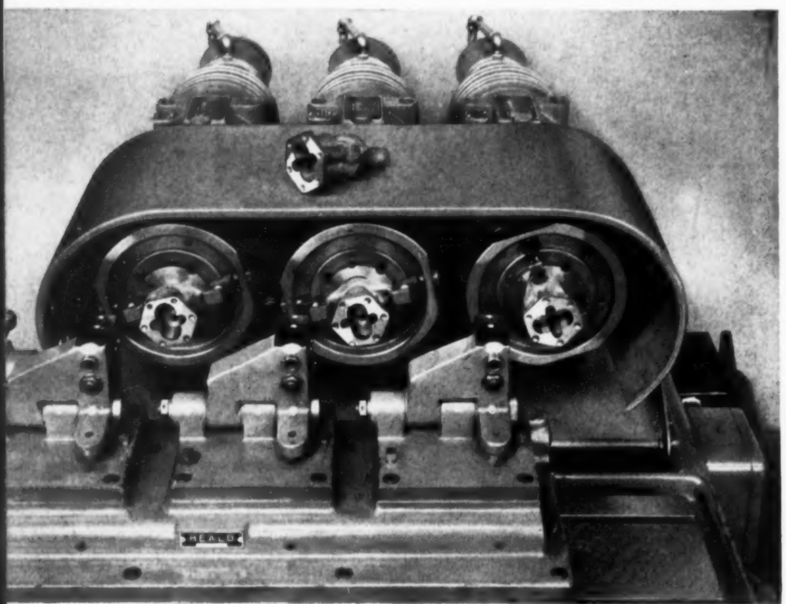


***Automobile Distributor Support 10 Inches Long with a 1 1/16-inch Hole 8 Inches Deep and a 1/2-inch Concentric Hole that Extends the Remaining 2 Inches. The Large Hole is Bored within 0.002 Inch for a Distance of 3 Inches and is Faced at the Bottom, and the 1/2-inch Hole is Bored within 0.0005 Inch. Cuts are Taken by Three Tools on One Quill. A Ball Bearing Guides Overhanging End of Tool***

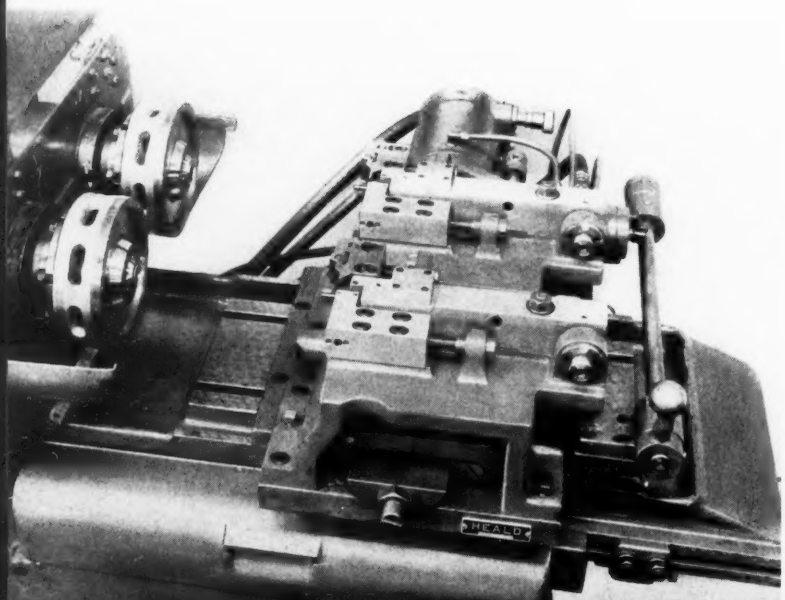

***Turning the Taper Valve Seat on Carburetor Needles Made of Stainless Steel. The Turning Tools are Mounted on a Hydraulically Actuated Slide That can be Positioned at an Angle to Suit the Taper of the Work. Collet Chucks Rotate the Needles at a Speed of 6800 Revolutions per Minute. Operation Entirely Automatic Except for Loading. Production 416 Needles an Hour***



***Boring a Hole 3 1/2 Inches in Diameter by 6 3/4 Inches Long in a Large Cast-iron Combination Clutch Hub and Back Plate for a Tractor. The Part is Chucked from the Outside Diameter of the Spur Gear Teeth in a Collet Equipped with Sliding Jaws. The Same Precision Boring Machine can Handle Seventeen Different Clutch Parts—a Versatility Seldom Found in High-production Equipment***

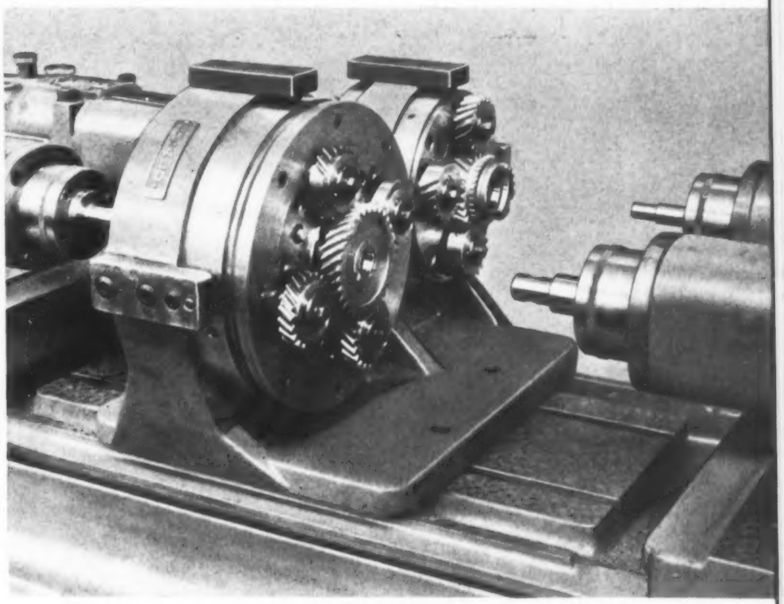


***The Application of a Precision Boring Machine to the Simultaneous Facing of Three Cast-iron Pump Bodies. The Parts are Revolved by Special Chucks and Faced by Tools Mounted on the Hydraulically Actuated Table. These Tools are Automatically Backed off at the End of the Cut to Prevent Drag Lines on the Work. Average Rate of Production, 2501 Pump Bodies an Hour***

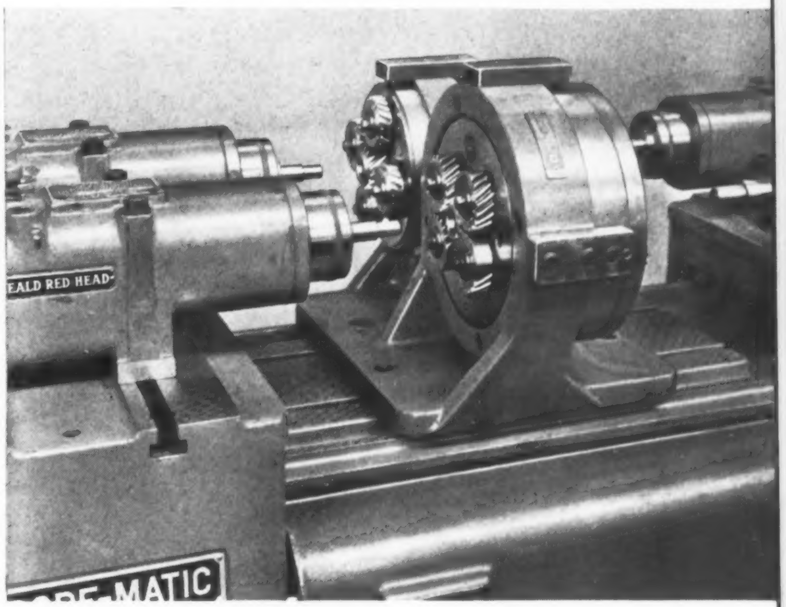


***Precision Boring Two Pistons for Shock Absorbers, and at the Same Time, Chamfering Four Corners of the Front End and Facing This End. The Pistons are Held in Diaphragm Type Chucks, while the Tools are Mounted on a Hydraulically Actuated Slide that is Moved both Lengthwise and Crosswise. These Parts are 1 Inch Outside Diameter by 5/8 Inch Long. They are Finished at the Rate of 600 Pieces an Hour***

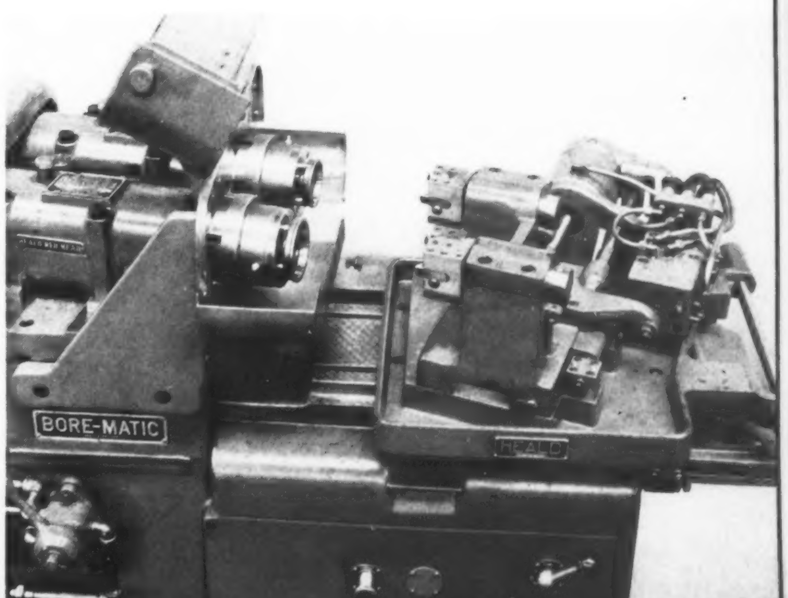
***The Bronze-bushed Holes of Three Different Transmission Gears—a Cluster Gear and Two Single Gears—are Bored with This Machine, which is Equipped with Four Boring Heads and Garrison Gear Chucks Designed for Helical Teeth. The Two Front Heads Bore the 1 3/4-inch Long Bronze Bushings in Opposite Ends of Cluster Gear Straight within 0.0001 Inch. The Rear Heads Bore the Single Gears***



***Another View of Transmission Gear Boring Machine, Taken from Opposite Side of the Garrison Chucks. The Holes Bored in These Gears Range from 7/8 to 1 3/8 Inches in Diameter and up to 1 3/4 Inches in Length. The Average Production is 45 Cluster Gears an Hour and 90 Single Gears. The Spindle Speed is 3120 Revolutions per Minute, and the Feed, 0.002 Inch***



***Approximately 20 Grooves, Spaced 0.020 Inch Apart and 0.010 Inch Deep are Taper-cut Simultaneously on the Inside of Two Brass Synchronizing Drums by This Machine. The Drums are First Rough Taper-bored, Then Grooved by a Succession of Plunge Cuts and Finally Finish-bored, in One Automatic Cycle. Air-operated Chucks Hold Work at an Angle. The Tools are Also Mounted at an Angle***



# Unusual Tooling Equipment for

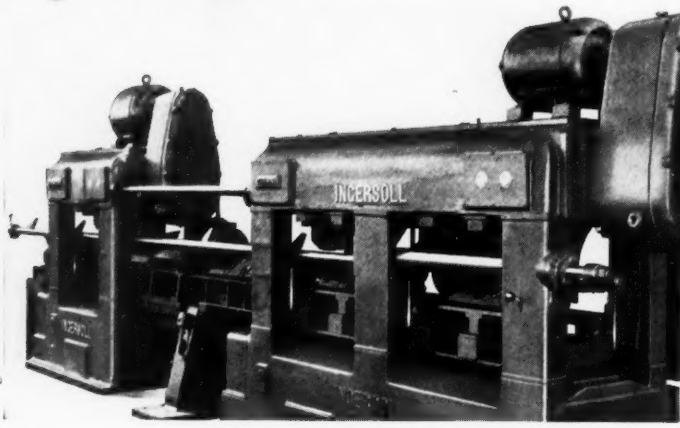



*Fig. 1. Boring the Cam and Crank Holes of V-type Automobile Cylinder Blocks in an Ingersoll Boring Machine*

THE rapid and accurate boring of the cam and crank holes of V-type automobile cylinder blocks as done in the Ingersoll boring machine, Fig. 1, introduces a rather unusual sequence of operations. The tools are carried on precision stub boring heads, so that only the tool need pass through the hole it is boring. No long piloting bars or tools are used which would have to be fed through the entire length of all the cam or crank holes.

The cylinder block is first placed in the boring position and clamped. After the boring tools have performed their work, they rapidly recede from the bore. Then the cylinder block is dropped on the conveyor line and automatically transferred to the next operation. The roughing and semi-finishing is done in a tandem machine, as indicated, while the finishing machine is a separate unit.

The tools or cutters used in these operations have a great deal to do with the success of this unusual method of boring. The rough-boring tools, Fig. 2, are of the solid type, tipped with cemented carbide. They have quite sharp shear angles. Separate inserted-blade heads are used for the larger counterbores. Single-cutter heads are also provided for rough-boring and counterboring the cam idler hole and for facing a boss at the rear end of the cam line. The four-bladed rough-boring tools rotate at about 150 surface feet per minute, taking a chip of 0.005 inch per tooth. Approximately 1100 pieces are bored per grind. Each tool has a life of from 18,000 to 25,000 cylinder blocks. The stock averages 1/8 inch on a side, and the holes are roughed to a tolerance of 0.006 inch, with 0.040 inch allowed for the semi-finishing cut.

The semi-finishing tools, Fig. 3, are two-bladed adjustable, inserted, serrated-blade cutters, tipped with cemented carbide. They run at 225 surface feet per minute, with a feed of 4 3/4 inches per minute, or 0.0065 inch per tooth. They average 2500 blocks between grinds. The semi-finishing

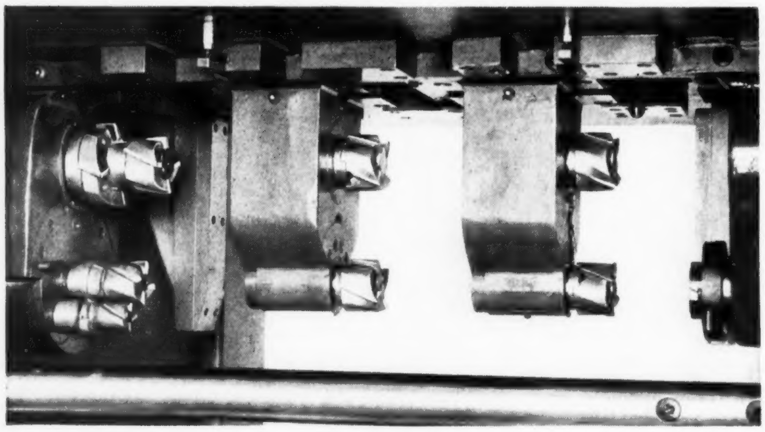
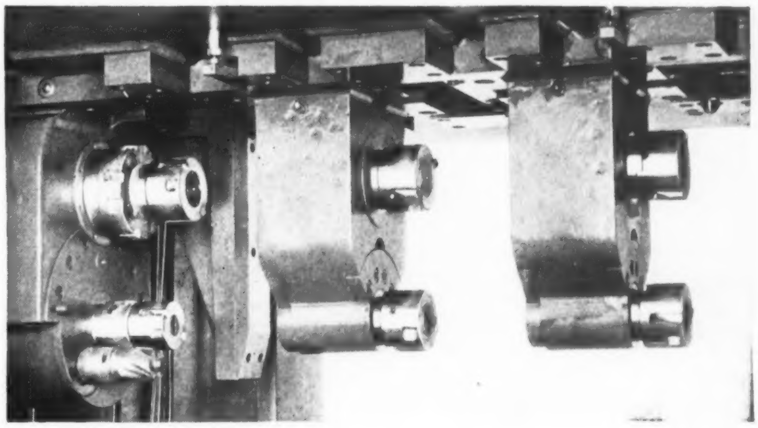


*Fig. 2. Rough-boring Tools of the Solid Type Tipped with Cemented Carbide, as Mounted in Machine*

# Boring Cam and Crank Holes

*Fig. 3. Semi-finishing Tools of the Two-blade, Adjustable, Inserted-blade Type, Tipped with Cemented Carbide*



tools remove approximately 0.020 inch on a side, and work to a tolerance of 0.005 inch.

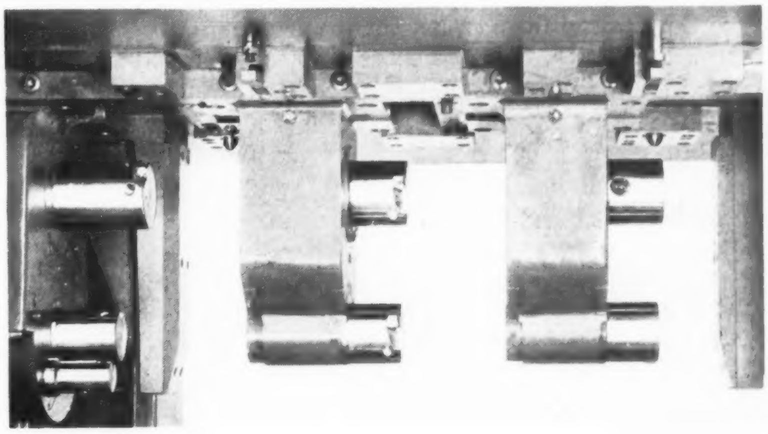
The final finishing of the cam and crank holes is performed with single-point fly-cutter heads, as shown in Fig. 4. A cemented-carbide tipped tool bit is inserted in a micrometer adjustable tool-head, which permits the tool bit to be adjusted to 0.0001 inch. The tolerance required in this operation is 0.0005 inch. The cutters rotate at about 325 surface feet per minute, with a 4 3/4-inch feed per minute, or 0.009 inch per revolution. The tools remove 0.006 inch on a side in this final cut, which is known as a diamond boring operation.

While this machine was built especially for work in the automobile industry, it is obvious that the principle involved can be applied with equally satisfactory results to any kind of precision boring operation where the conditions are sufficiently similar to warrant the installation of this kind of machine and tool equipment.

## *Automobiles—The Nation's Largest Tax Source*

A significant fact in connection with the attitude of federal and state executives in the automobile strike is that the automobile is one of the nation's biggest sources of taxes. It is an industry that should be encouraged rather than hampered. If state taxes alone are considered, they amounted to nearly a billion dollars for 1935, and are undoubtedly well over a billion for 1936. Retail sales taxes on automotive products in 1935 are calculated by the American Manufacturers' Association to total \$48,802,000; car registration fees added \$322,481,000; and gasoline and oil taxes amounted to \$616,852,000, making a total of \$988,000,000 from these three sources alone. This ignores entirely the immense property taxes on the many plants, warehouses, retail stores, etc., as well as all federal taxes.

*Fig. 4. Single-point Fly-cutter Heads Used for the Final Finishing of the Cam and Crank Holes*



# New Upsetting Method Speeds Up

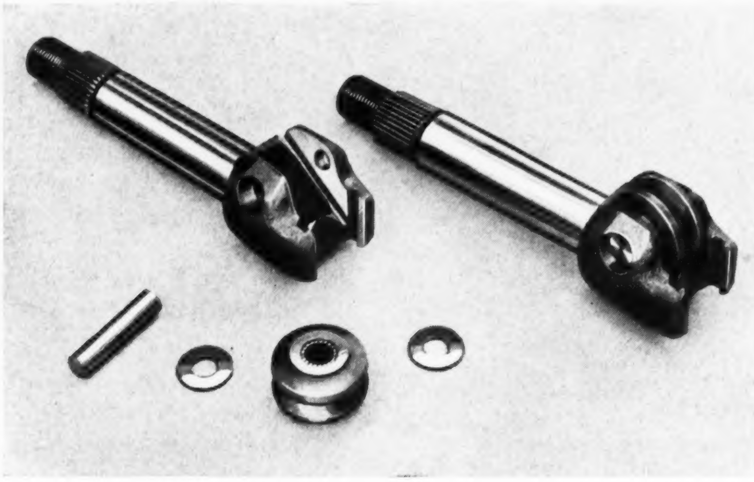


*Fig. 1. Parts that Make up a Shaft Unit for Gemmer Steering-gear Mechanisms, and an Assembled Shaft Unit*

THE shaft units of steering-gear mechanisms made by the Gemmer Mfg. Co., Detroit, Mich., are made up of the shaft itself, a roller, a roller bearing, two washers, and a pin. These parts, which are shown at the left in Fig. 1, are assembled as shown at the right. They are held permanently together by upsetting the ends of the pin in an operation which consists of heating the pin ends to a dull red by the application of electrodes, and then exerting a heavy pressure through the electrodes. This operation is performed in machines of the type illustrated in Fig. 2, which are built by the Multi-Hydromatic Welding & Mfg. Co., also of Detroit.

Great care is taken in the manufacture of the different pieces that make up this shaft unit to insure the desired fit between them when the unit is placed in service. The washers and the roller are lapped on the sides to almost a wringing fit, and the jaw sides on the shaft head are ground to size within a close tolerance. An important consideration in the assembling operation, therefore, is to guard against exerting so much pressure in the upsetting as to bind the roller or washers in the head of the shaft or to cause deformation of the pin inside of the roller bearing. It is equally important to avoid heating the pin ends for too great a length, because the rollers of the bearing must not be deformed by the heat.

In the steering-gear shaft unit illustrated, the pin is 9/16 inch in diameter and is upset for a length of 3/32 inch only, at each end. The upset pin ends fill the counterbored recesses in the head of the shaft. For the upsetting operation, each assembly shaft unit is placed in the machine with the roller engaging the locating finger *A*, Fig. 2, the shaft itself resting in block *B*. This block also locates the shaft unit lengthwise, so as to bring the pin to be headed into line with the electrodes on heads *C* and *D*. The shaft unit is held in place by means of an air-actuated clamp *E*, which is automatically lowered on the work when the operator opens a valve.

At the same time, an air cylinder at the rear of the machine, through a series of toggles, advances the electrodes of heads *C* and *D* against the ends of the pin. Electric current is then discharged from the electrodes and also from contact points on clamp *E*. The period of electrical discharge is regularly between ten and fifteen cycles, so as to closely control the depth of heat penetration at the ends of the pin.

When the pin ends have been heated the required amount, the toggle mechanism exerts a pressure endwise on the electrodes to upset the pins in the manner already mentioned. This pressure can be varied to suit pins of different diameters.

A factor of great importance in the successful

# Steering-Gear Assembly Work

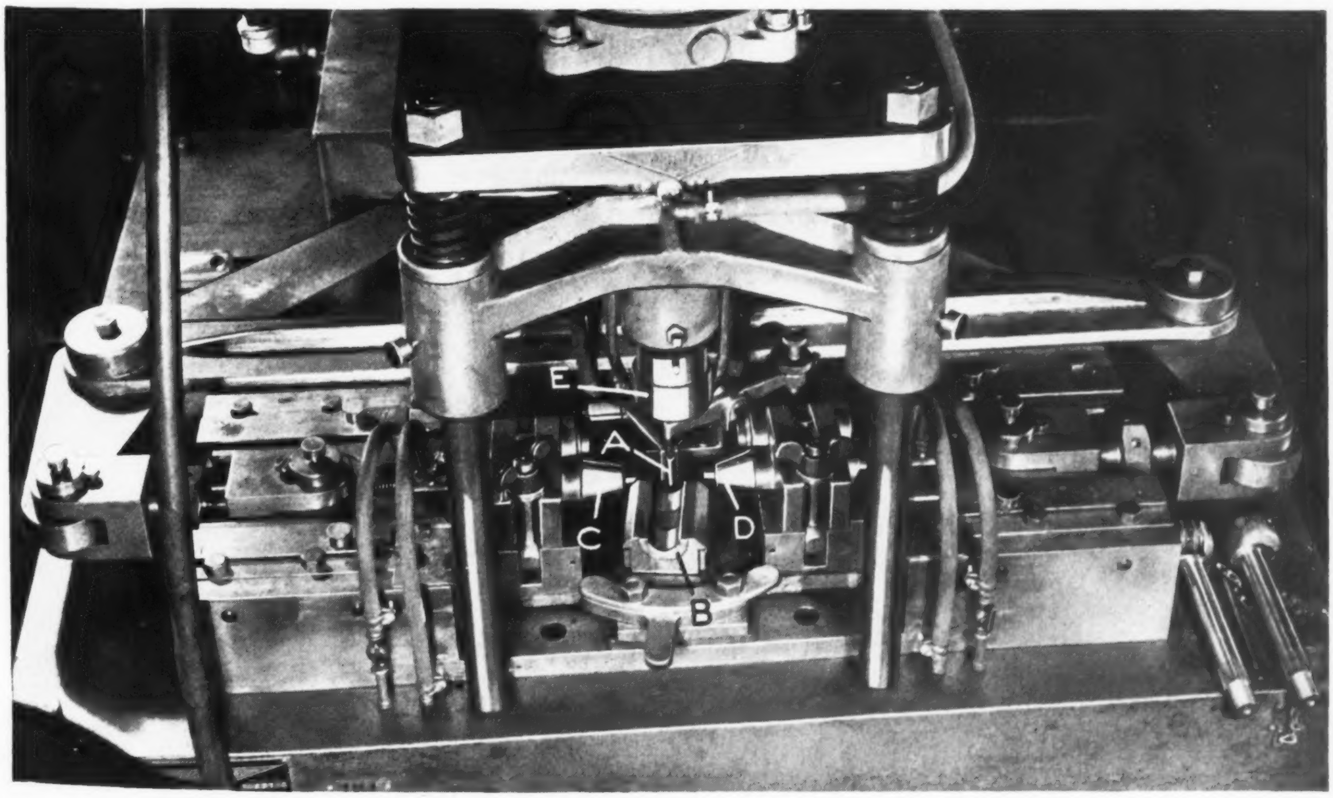
operation of these machines is to provide electrodes that will withstand the heavy upsetting pressure. Electrodes made from a highly conductive copper alloy that is a product of the S. M. S. Corporation of Detroit, are being used. They are 5/8 inch in diameter by 5/8 inch in length, and are silver-soldered into the holders which are also made from an alloy that possesses good conductivity. Water for cooling purposes is continuously circulated to the electrode-holders and also to the vicinity of the contact points in clamp *E*.

This equipment constitutes an interesting example of how electrical and mechanical means can be used in combination to obtain simply a result that otherwise could be produced only by rather cumbersome operations. The substitution of pneumatic pressure for a purely mechanical pressure also simplifies the design of the entire machine for this steering-gear assembly.

## *Airplanes Impossible Without Modern Machine Tools*

Those who decry the increased use of machinery in production often overlook the fact that many of the products of modern civilization could not possibly be produced by hand labor, or by the more primitive types of machines, in the operation of which hand labor forms an important part, irrespective of whether the products are made in quantity or not. "The airplane of today," states a leading aircraft manufacturer, C. N. Monteith, vice-president of the Boeing Aircraft Co., "could not be produced according to the shop methods of earlier days—and yet there is no such thing as mass production in our industry. So far, the largest order for aircraft placed by the United States since the World War totaled but 200 units, and hence the term mass production does not apply to aircraft."

*Fig. 2. Machine in which the Steering-gear Shaft Units are Assembled by Upsetting Both Ends of the Pin after They have been Electrically Heated*



# *The Industry that Led the Recovery*

THE automobile industry continues to remain the largest mechanical industry in America and the outstanding factor in the general business recovery. This position the industry held throughout the depression. Even in 1932, when the production fell to less than 25 per cent of that in 1929, the industry was still the most important single factor in industrial employment and in the effect that it had on the recovery of other industries. Today, it leads in industrial employment.

DIRECTLY and indirectly, the industry provides work for over 6,000,000 people, not including the half a million or more employed in the manufacturing of equipment and materials for roadbuilding, and the great number employed in producing equipment and materials for the industry itself. How large this number is may be judged from the fact that the automobile industry is the largest single purchaser of rubber, steel, malleable iron, mohair, lubricating oil, plate-glass, nickel, and lead in the country. As a buyer of machine tools and shop equipment, it ranks first. Directly and indirectly, the industry is responsible for at least one-third of the output of machine tools and shop accessories.

WHILE everyone recognizes the magnitude of this industry, few have an adequate conception of the dominating position that it occupies in our industrial and economic life. The total number of carloads of automotive freight shipped over our railroads, for example, amounted in 1936 to 3,525,000—the equivalent of the total carloadings of the entire country for approximately five weeks. The value of cars, accessories, and service equipment made amounted to over $3,600,000,000, while the gasoline consumption accounted for $3,300,000,000 more, or a total of more than 10 per cent of the entire national income. In addition, close to $1,000,000,000 was expended on the building and maintenance of highways—supporting, it is estimated, 950,000 families. The industry and the users of automobiles paid in taxes on cars and gasoline close to $2,300,000,000, or 14 per cent of all taxes—federal, state, and local.

STATISTICS make dry reading, but it is important to recognize that this industry is the keystone in our industrial structure. Through courage and enterprise, it has contributed more than any other one factor to the industrial recovery of the nation. Success in the automobile industry means progress in all other industries. Serious setbacks to that industry mean curtailed business in practically every other industrial field. It is the greatest producer of a consumer product, and, as such, it has become a gage of the industrial activity throughout the nation. It is an industry that deserves fair treatment by the Government, and a common-sense attitude on the part of labor. What helps that industry helps the country as a whole. What hinders and retards it will prove a handicap to every man and woman engaged in a useful activity.

BECAUSE of the great importance of this outstanding industry, MACHINERY once a year gives especial attention to the machines, methods, and processes used in automobile plants. These methods are the most advanced in the mechanical field, and will be found applicable, directly or in modified form, in almost every other branch of industry where production and accuracy are factors.

# *High-Production Turning and Facing of Transmission Gears*

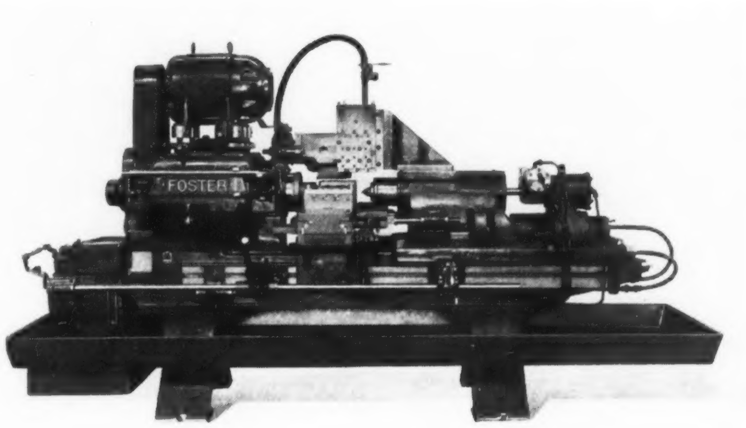
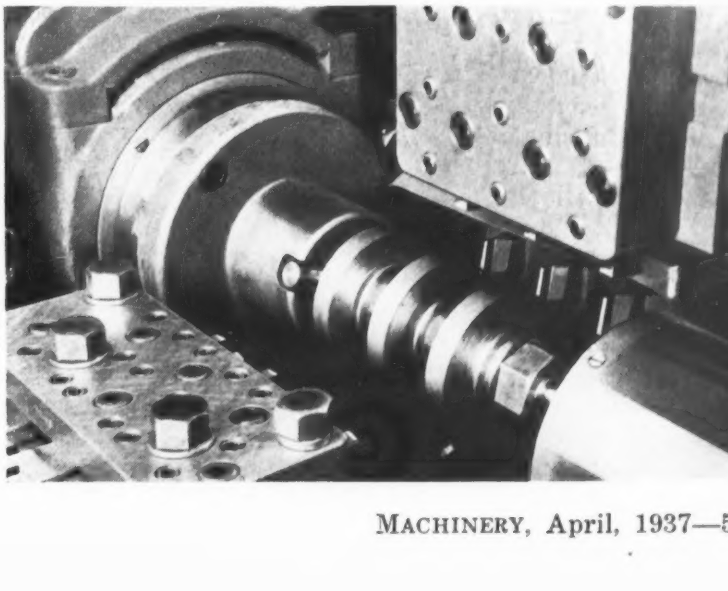


*Fig. 1. Fastermatic Equipped for the Simultaneous Turning, Facing, and Grooving of Three Automobile Transmission Gear Blanks*

THREE automobile transmission gears are simultaneously rough-faced on both sides, rough-turned on the periphery, and turned and grooved on the hub in a center type Fastermatic, recently built by the Foster Machine Co., Elkhart, Ind. The gears are faced on both hubs and spline-broached before coming to the Fastermatic. They are loaded on a splined arbor and placed in the machine with the driving end of the arbor supported in a taper socket in the drive-plate. The opposite end is supported by a rotating center in the pneumatically operated tailstock.

The periphery of the three gear blanks is turned by "overshot" tools arranged on a heavy slide at the rear of the machine, as shown in Fig. 2. This slide is fed forward rapidly by a hydraulic mechanism, and at the same time, the tool-head is moved downward by a cam. When this movement is completed, the slide dwells with the cutters in position for turning the periphery of the gears. At the same time, cutters on the front cross-slide are brought into position by a cam for straddle-facing the sides of the gears, and the gears are turned on the periphery and hubs, and faced on the sides. The front cross-slide now dwells while tools mounted on the rear cross-slide cut a groove in the hub. Then all tool units rapidly return to their starting positions. Each operating cycle requires one minute and twenty seconds, a production of approximately 135 gears an hour. While the machine is in operation, the attendant reloads work on another arbor, ready for the next cycle.

*Fig. 2. A Close-up View of the Tools Employed on the Fastermatic for Taking the Turning, Facing, and Grooving Cuts on Gear Blanks*



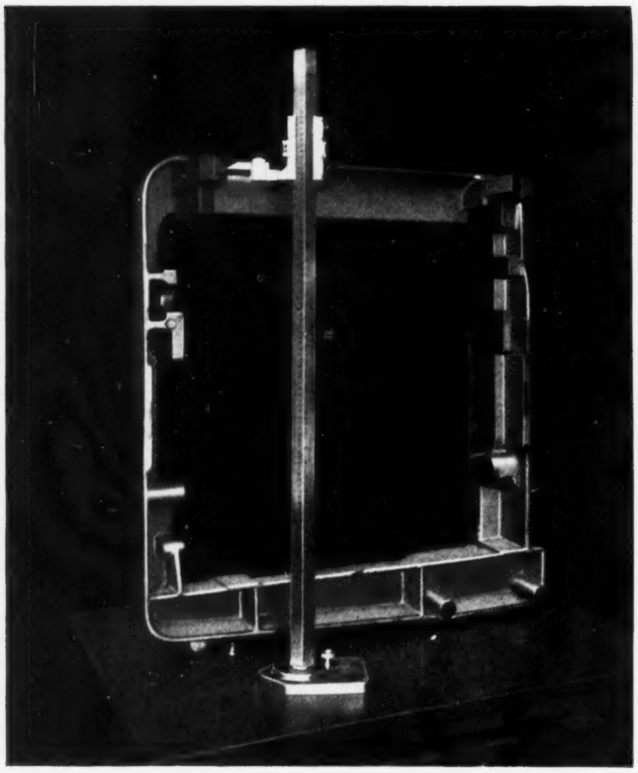


Fig. 1. A 40-inch Height Gage Facilitates the Laying out of a Large Metal Pattern without Requiring Parallel Blocks to Increase its Range

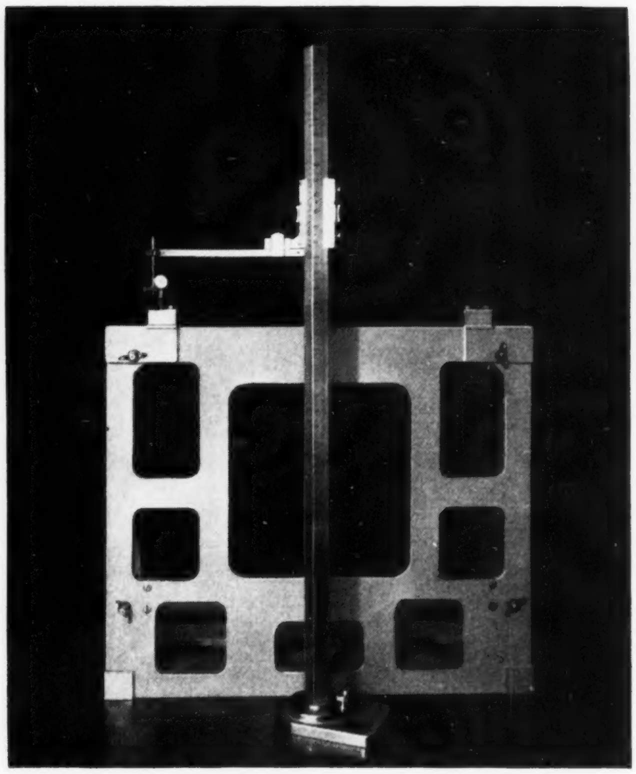


Fig. 2. A Tool-room Application of the Chesterman Height Gage—Used with a Dial Indicator to Check Dimensions of a Machine Side-frame

# The World's Largest Height Gage

A 40-INCH height gage facilitates the accurate lay-out of castings to be machined, the set-up of machine tools for precise jobs, and the inspection of finished work in the shop of the Intertype Corporation, Brooklyn, N. Y. Typical applications of this gage are shown in the accompanying illustrations. Fig. 1 shows the height gage being used in scribing the location of holes to be accurately bored in a metal pattern that is approximately 36 inches square. The pattern is set up on a surface plate and held vertically by clamping against an angle-plate. The different hole locations are conveniently laid out by the use of the height gage alone, whereas when a shorter height gage was used, it was necessary to use parallel blocks on top of each other in order to obtain the required heights. Inaccuracies of a "few thousandths" were likely to occur when the blocks became worn.

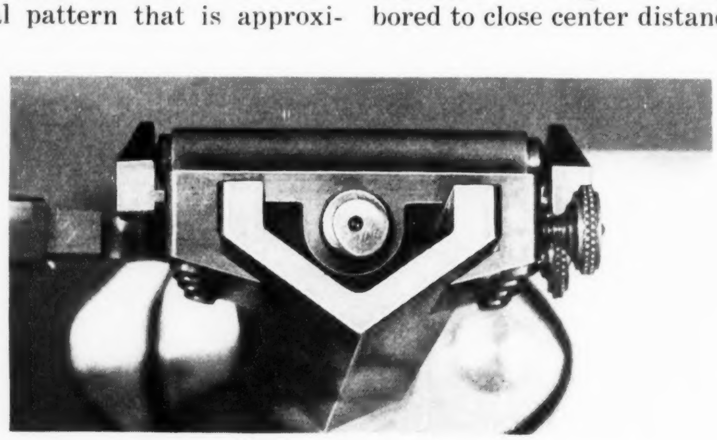


Fig. 3. A Triangular Cross-sectional Construction Provides the Required Strength and Rigidity for a 40-inch Height Gage

Dimensions of a machine side-frame are shown being checked in Fig. 2 by means of the height gage and an indicator dial substituted on the sliding head for the scriber seen in Fig. 1. The manner of using the height gage on a machine tool is illustrated in Fig. 4. A series of holes must be bored to close center distances in the large machine casting that is seen on the table of the boring mill. The height gage enables the tool-spindle to be quickly positioned for boring each hole, as far as the height dimension is concerned.

This height gage, which is believed to be the largest of its type made commercially, is a product of James Chesterman & Co., Ltd., Sheffield, England, and was re-

cently introduced on the American market by the George Scherr Co., 124 Lafayette St., New York City. The upright beam is graduated on one side to 0.050 inch for its full length, but in addition, there is a vernier 2 1/2 inches long which is graduated to 0.001 inch. The thousandth-inch graduations are far enough apart to be easily read with the naked eye, eliminating the necessity of picking up the gage in order to observe a reading. The opposite side of the beam and of the sliding head is graduated in millimeters for shops in which the metric system is used. A cylindrical gage-block is supplied for checking the vernier settings.

Quick adjustments of the sliding head are made by merely compressing two lugs on the side of the head with one hand, so as to disengage a split nut from a micrometer adjusting screw which extends the full height of the scale beam. The head can then be readily moved to any approximate position on the scale. Fine adjustments are accomplished, after the lugs on the sliding head have again been released to permit the split nut to engage the adjusting screw, by turning the knurled head of a pinion-shaft in the base of the height gage. The pinion on this shaft meshes with a gear on the lower end of the adjusting screw.

The depths of holes with respect to other surfaces can be determined by applying a depth rod to the scriber in such a way that the rod can be brought into contact with the inner end of the hole. The strength and rigidity necessary in a 40-inch height gage to guard against swaying or vibration during use are obtained by making the scale beam of a triangular cross-section, as shown in Fig. 3, in which the sliding head is seen near the top of the beam. The scale beam, sliding head, and solid base are hardened and ground all over for accuracy and high quality finish. The bottom surface of the base is lapped flat to insure a firm foundation for the gage. In addition to the 40-inch height, this gage is also available in heights of 12, 18, and 24 inches.

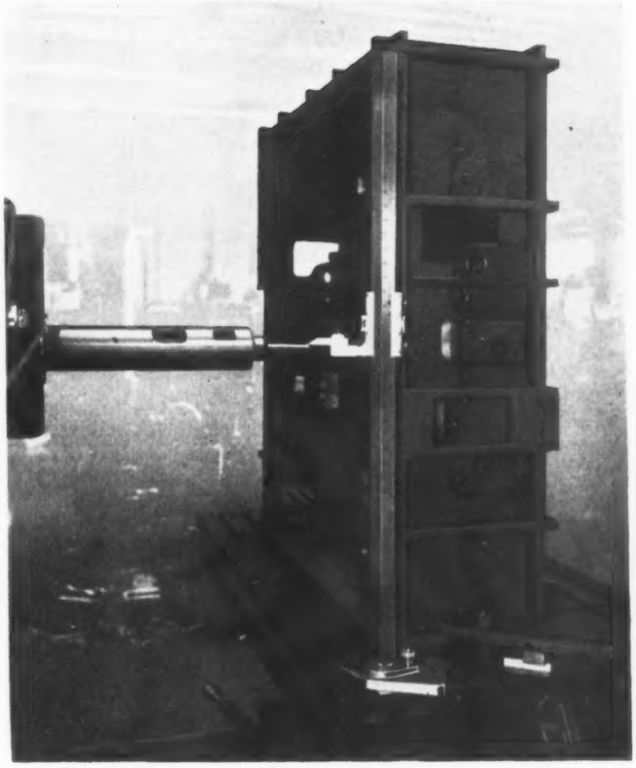


Fig. 4. Applying the Height Gage in Setting the Tool-spindle of a Boring Mill for the Accurate Machining of a Large Jig Casting

# Importance of Packaging in Modern Industry

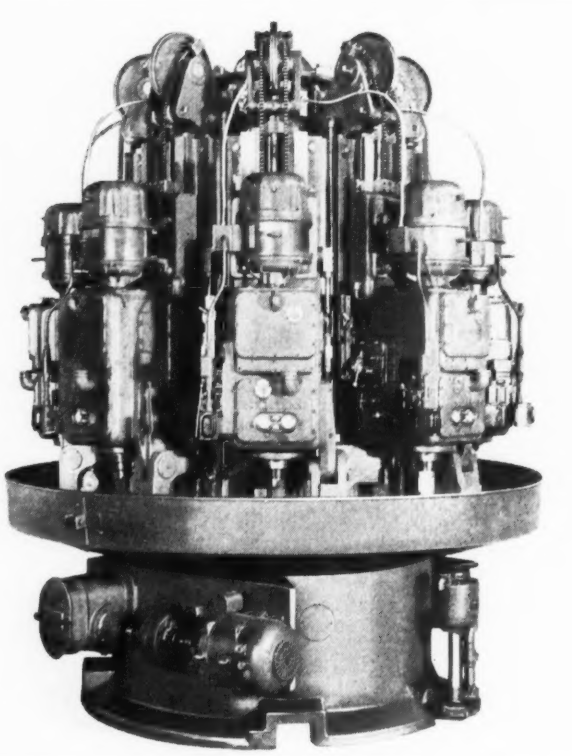
IT is estimated that the value of the containers for consumer and industrial products runs into several billion dollars annually. There has been a tremendous expansion in this industry. Attractive packaging has become one of the important items in the merchandising of all classes of products. In this field, an outstanding annual event is the award of prizes in the All-America Package Competition sponsored by *Modern Packaging*. This year four prizes were awarded in the packaging machinery group for packing performed by equipment of ingenious design. The gold and silver awards were presented to Ben Burk, Inc., Boston, Mass., and the Parker Pen Co., Janesville, Wis., respectively.

Other concerns in the mechanical field that were presented with awards included the Borg-Warner Service Parts Co., Chicago, Ill., for an attractive king-pin kit; the Dole Valve Co., Chicago, Ill., for the packaging of valves; the Remington Arms Co., Inc., Bridgeport, Conn., for its plastic containers for cutlery; and the Oxweld Acetylene Co., Newark, N. J., for shipping containers.

In all, fifty-six awards were made at a dinner, at which were present several hundred representatives of the companies who contributed to the design or making of the winning products. The prize winners were selected from 12,000 entries.

The winning containers are now on display at Rockefeller Center in the south corridor of the Arcade at 30 Rockefeller Plaza, New York City. Duplicate sets for exhibit will go to England and Australia, and twelve traveling exhibits will tour the country for display in advertising clubs and merchandising outlets. Accompanying these exhibits will be a feature-length, color and sound moving picture, showing graphically the importance of packaging in the protection of products, in the building up of sales, and in advertising and display.

# Turning and Crowning Automobile Pistons in a Vertical Lathe



CAST-IRON automobile pistons are being rough-turned and crowned at the rate of 400 an hour, based on an efficiency of 85 per cent, in the eight-spindle vertical lathe shown in Fig. 1, which was built by the Sundstrand Machine Tool Co., 2531 Eleventh St., Rockford, Ill. The pistons are 3 1/2 inches in diameter by 4 1/4 inches long. A rough casting is shown at the left in Fig. 2, and a turned and crowned piston at the right. Tungsten-carbide cutting tools are used, and there is provision for supplying coolant copiously for carrying away dust and chips and keeping the tools and work cool.

The machine is constructed with a rotating octagonal column, driven by a motor through a speed reducer and a gear-box which provides for changing

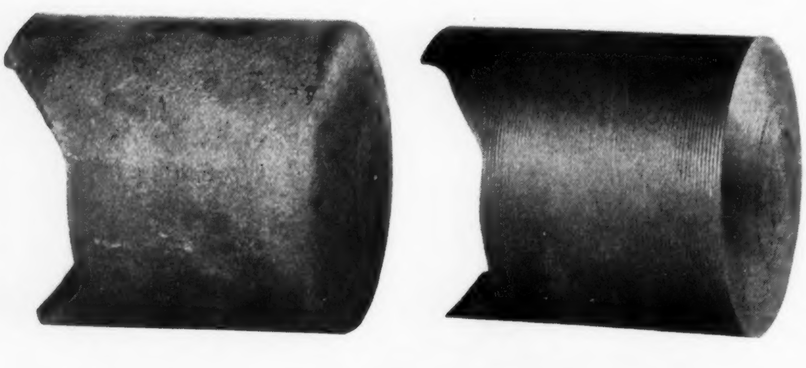


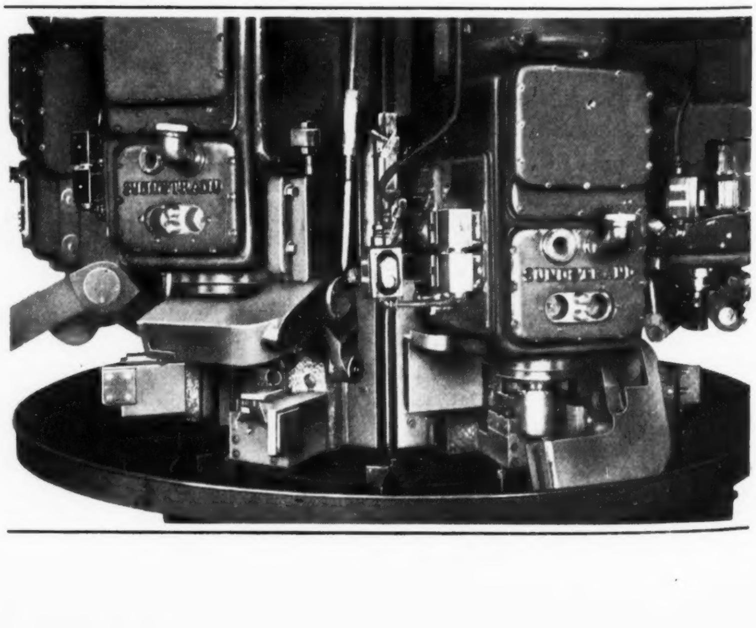
Fig. 1. (Above) Eight-spindle Continuous Vertical Lathe which Rough-turns and Crowns 400 Cast-iron Automobile Pistons an Hour

Fig. 2. (Left) One of the Rough Piston Castings and a Piston that has been Rough-turned and Crowned in the Machine Illustrated in Fig. 1

Fig. 3. (Below) The Pistons are Turned by a Tool on a Stationary Block beneath Each Hydraulic Unit, and are Crowned by a Tool on a Swinging Holder, Actuated by the Downward Motion of the Hydraulic Unit

the column speed. On each face of the column there is a sub-base having ways on which a Sundstrand self-contained hydraulic unit travels vertically. The automatic cycle of these units consists of a rapid approach, feed, and quick return. Each unit is equipped with a hydraulically operated expanding chuck for the work, the chuck being controlled through push-buttons.

A stationary tool-block is mounted at the lower end of each sub-base, as seen in Fig. 3. As the central column revolves, the downward movement of the corresponding hydraulic unit feeds the work against the tool in this block for turning the piston. Pivoted on the side of each



hydraulic unit is a bellcrank, the inner end of which is connected to a stationary adjustable rod. This arrangement causes the bellcrank to swing on its pivot as the hydraulic unit moves downward, so that, at the proper time in the cycle, a tool on an arm of the bellcrank turns the curved head of the piston to the desired radius.

In normal operation, the central column revolves continuously. As a hydraulic unit approaches the operator, he presses a push-button on a control box, which causes the chuck of that unit to contract and release the work. The operator then substitutes a rough casting for the piston just machined and presses a second button of the control box to expand the chuck for gripping the new piece. As the column rotates from this point, it passes a limit switch which starts the automatic cycle of the hydraulic unit on which the work has just been changed. By the time that this unit again reaches the operator, it has completed its cycle and the other seven hydraulic units have also been reloaded.

The hydraulic units are completely independent of each other and, consequently, one or more units may be removed from the machine without interfering with the operation of the remaining ones. Although this machine is illustrated set up for pistons, it can be applied to a large variety of work.

## The Census of Machine Tool Manufacture in 1935

The figures covering the complete statistics of the machine tool industry in 1935 have just been made public by the Bureau of the Census, Washington, D. C. These figures show striking increases, compared with 1933, the last previous year when a machine tool census was taken. The census of manufactures is taken every other year.

Machine tool manufacturers employed, on an average, 28,186 wage-earners in 1935, compared with 12,714 in 1933. The wages paid in 1935 amounted to over $37,260,000, compared with $12,596,000 in 1933. The total production of machine tools was valued at over $85,000,000 in 1935, compared with slightly under $24,000,000 in 1933.

The machine tool industry, as defined for the purposes of the census, embraces establishments engaged primarily in the manufacture of power-driven machines generally defined as machine tools. According to the census, there were 259 establishments manufacturing machine tools in 1935, compared with 232 in 1933, and 279 in 1931. Detailed statistics on the production of machine tools in 1935, compared with 1933, were published in March MACHINERY, page 470.

## *Prize Winners in MACHINERY'S Modern Equipment Contest*

***The winners of the prizes in MACHINERY'S Modern Equipment Contest have now been selected by the judges of the contest—Norman D. MacLeod, President (1936), National Machine Tool Builders' Association; N. A. Booz, President (1936), Associated Machine Tool Dealers; and Erik Oberg, Editor, MACHINERY. This contest was announced in June, July, and August MACHINERY, and closed October 1, 1936. The winners of the prizes are as follows:***

***FIRST PRIZE: H. H. Moor, Micro-Westco, Inc., Bettendorf, Iowa.***

***THREE SECOND PRIZES:***

***Richmond Viall, Brown & Sharpe Mfg. Co., Providence, R. I.***

***M. R. Crossman, Gisholt Machine Co., Madison, Wis.***

***R. C. Becherer, Ewart Works, Link-Belt Co., Indianapolis, Ind.***

***ADDITIONAL PRIZES AWARDED TO:***

***R. C. Heinmiller, Foote-Burt Co., Cleveland, Ohio.***

***I. F. Yeoman, Elkhart, Ind.***

***E. A. Murray, Chesapeake & Ohio Railway Co., Huntington, W. Va.***

***Douglas T. Hamilton, Fellows Gear Shaper Co., Springfield, Vt.***

***R. L. Rickwood, Blanchard Machine Co., Cambridge, Mass.***

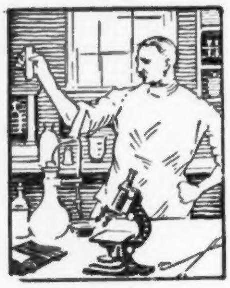
***J. M. Davis, Union Die Casting Co., Ltd., Los Angeles, Calif.***

***James W. Gibbons, American Sugar Refining Co., Brooklyn, N. Y.***

***H. L. Green, Reska Spline Products Co., Detroit, Mich.***

***The prize-winning articles will be published in coming numbers of MACHINERY, beginning with the May issue.***

# MATERIALS OF INDUSTRY



THE PROPERTIES AND NEW APPLICATIONS OF MATERIALS USED IN THE MECHANICAL INDUSTRIES

## Carboloy-Tipped Drill Penetrates Two Miles of Cast Iron

A 9/16-inch drill tipped with Carboloy produced 100,247 holes, 1 3/8 inches deep, in iron castings during its lifetime, in the Fort Wayne Works of the General Electric Co. Each hole required eight or nine seconds for drilling, the feed rate being approximately 10 inches a minute. An average of about 2500 pieces were drilled between grinds. All together, the drill penetrated through more than two miles of cast iron before it had to be scrapped.

## Stainless Steel "Dresses up" 1937 Automobiles

Stainless steel has been utilized extensively in this year's automobiles to give a lasting attractive appearance. The *Electromet Review* points out, for instance, that the hub caps on Ford and Lincoln automobiles will never rust or tarnish, being made of stainless steel. The steering wheels on some cars are made with spokes of stainless steel, and the exhaust pipes of the new super-charged Cord are covered with flexible jackets made of the same material. Bell-shaped louvers of stainless steel brighten the radiator grille of the Oldsmobile Six, which strikes a keynote of originality in radiator grille design.

The Bell-shaped Louvers on the Radiator Grille of the Oldsmobile Six are Made of Stainless Steel

## Which Nickel Steels are Oil-Hardened and which are Water-Hardened?

Nickel alloy steels may be divided into two classes, according to the International Nickel Co., 67 Wall St., New York City. The first class comprises the carburizing steels, which contain up to about 0.25 per cent carbon. These steels are used when a hard, wear-resistant surface is required, in combination with maximum toughness or resistance to shock. The second class includes the oil- and water-hardening steels, which contain from about 0.25 to 0.50 per cent carbon and are uniform in carbon content throughout. These steels are frequently used when machining is done after heat-treatment to obtain smooth scale-free surfaces of dimensional accuracy.

Steels with a carbon content of less than about 0.30 to 0.35 per cent are water-hardened in sizes between 3/4 inch and 2 1/2 inches in diameter or thickness, while steels with higher carbon contents in the range previously mentioned are oil-hardened. The choice of the quenching medium, however, also depends upon the alloy content and the size and shape of the piece.

Steels with the highest proportions of alloying elements, such as the S A E 3300 series are generally oil-quenched, even in the low-carbon grades. Steels with intermediate proportions of alloying elements and higher carbon contents, as, for example, S A E 2340, are sometimes water-quenched in both small and moderately large sections, say from

1 to 4 inches in diameter or thickness. On the other hand, parts made of this steel that have sharp corners or large changes in sectional area are preferably oil-hardened to avoid distortion and cracking. Oil-quenching is also employed for sections less than 5/8 inch in diameter or thickness of the so-called water-hardening steels.

Each of the quenching mediums has certain advantages and disadvantages. A more thorough and deeper hardening is said to be obtained in water-quenching than in oil-quenching, and water-hardened steels can often be tempered at higher temperatures than oil-quenched steels of the same quality and composition to provide the same yield points, strength, or hardness. This is sometimes advantageous, as stresses are more completely removed and higher ductility and impact resistance obtained.

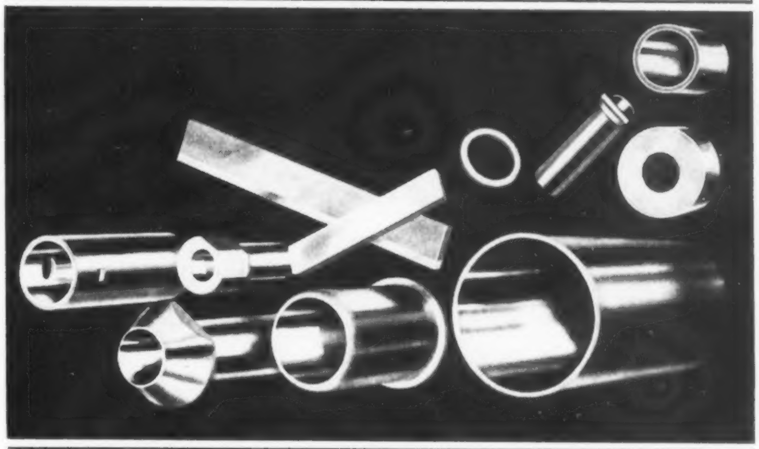
Water-quenched steels come out of the bath cleaner than oil-hardened steels, and the water-hardening process is cheaper. However, the temperature and the circulation of the water must be watched more closely, to insure uniformity, than in the case of the usual commercial quenching oils. These differences, along with the greater speed of cooling in water-quenching which increases the temperature gradients, makes water-quenching somewhat more hazardous than oil-quenching.

The choice of a steel to be hardened and tempered for a given application depends, of course, upon the required performance and the desired properties. Frequently more than one of the commercial nickel alloy steels meet the strength, ductility, and impact test requirements, and then the selection is dependent upon economic factors, in which the price of the steel per pound is balanced against the costs of fabrication, machining, and heat-treatment; the ease of reproduction; and the spoilage or risks in the processing technique.

## Xaloy—a Bonded Alloy that is Hard Enough to Cut Glass

"Xaloy" is the name that has been given to a metal coating that can be applied to the inside or outside of bushings or other tubular pieces, bars, etc., to resist abrasive wear. The alloy has been used for some time in oil-well equipment under the name "I. R. Metal"; it has now been made available to a broader field through the Wilcox-Rich Division of the Eaton Mfg. Co., Detroit, Mich., under license from the Industrial Research Laboratories, Ltd.

Xaloy has a hardness of from 700 to 750 Brinell or 68 to 70 Rockwell C-scale. It has a tensile strength of 43,000 pounds per square inch and a compression strength of 240,000 pounds per square inch. Typical parts coated with Xaloy are shown in the illustration. Some are coated on the inside, others on the outside, and still others on both the inside and outside. The coating is cast by a centrifugal method. Xaloy can also be applied to irregular surfaces by casting in a permanent or sand mold or by using inserts faced with the material. Narrow flat surfaces or edges are also coated by the centrifugal casting method.



Steel Parts Given Extremely Hard Inner or Outer Surfaces by Coating with Xaloy

This coating is of uniform appearance and thickness, the thickness being controlled closely so as to reduce to a minimum the finishing operation, for which special honing and grinding equipment is required. The resulting surface is mirror-like and has an unusually low coefficient of friction.

In the machine shop field, typical parts that can be coated with Xaloy are drill and reamer bushings, deep-drawing dies, sizing dies, work-rest blades, ring and plug gages, pilot bars, and valves. It is claimed that the life of tool bushings has been increased as much as 600 per cent when coated with this material. It has also proved satisfactory for cylinder liners in internal combustion engines.

## When Platinum was a Worthless Metal

Platinum was used by a Spanish counterfeiter in the Eighteenth Century to make spurious gold doubloons, according to an item that recently appeared in the *White Metal News Letter*, of the International Nickel Co. As platinum was considered almost worthless and its weight was approximately the same as that of gold, this enterprising searcher for riches conceived the idea of striking the coins from platinum and then gilding them to look like real gold. For his ingenuity, he lost his head.

The real gold doubloons were worth slightly over $8, whereas the value of the metal in the platinum counterfeits has since been as high as $40.

# Broaching Seat-Adjuster Rods in an Automatically Loaded Machine

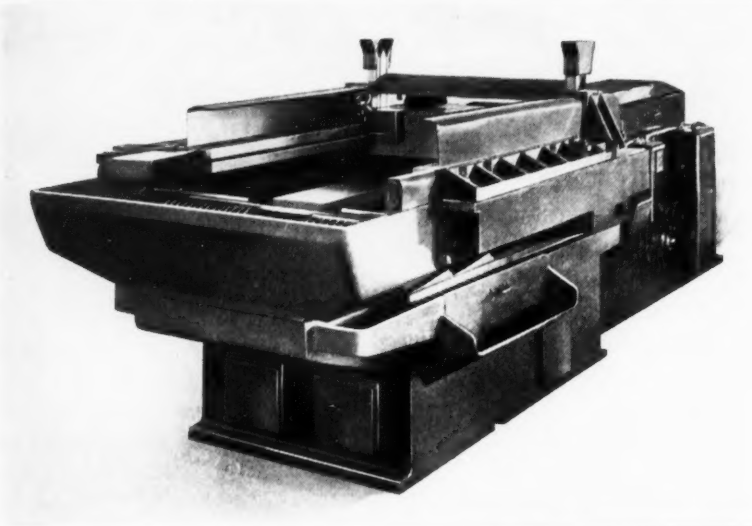


*Fig. 1. Automatically Loaded Broaching Machine that Finishes the Ends of Seat-adjuster Rods to Length, and then Broaches a V-slot and Two Flat Surfaces on Each End*

THE adjustable front seats of automobiles are customarily provided with cross-rods on the ends of which gears are mounted that roll on a concealed rack when the seat is moved forward or backward. By this means, alignment of the seat is maintained and adjustments effected without undue friction. Flat surfaces for mounting the gears must be machined on the top and bottom of both ends of these rods, as well as grooves for locking purposes.

These surfaces, and also the ends of the seat-adjuster rods, are now being broached on the machine here illustrated, which is an adaptation of the high-speed horizontal automatic pusher type machine built by the Colonial Broach Co., Detroit, Mich. A quantity of adjuster rods are loaded at one time into the magazine near the middle of the machine, as seen in Fig. 1. They are released automatically, two at a time, to the work fixture, which carries them along broaches arranged on both sides of the machine, as illustrated in Fig. 2. The completed rods are ejected at the front end of the machine. The machine cycle is thus entirely automatic and continuous.

The broaches are so arranged as to first rough-shear the ends of the rods to length. When the rods drop into the work fixture, they are automatically positioned so as to project the same amount at each end of the fixture. Thus the amount of stock sheared off is equally divided between the two ends.

Next the V-slot is broached in both ends for locking the assembled gears on the rod. Then the two flats are broached on each end. After the finished rods have been ejected at the end of the machine stroke, the work fixture returns to the position shown in Fig. 1 to receive two more blank rods.

This machine is hydraulically operated at a cutting stroke of 30 feet a minute and a fast return of 60 feet a minute, which results in a production of approximately 600 rods an hour. A variable-speed control is provided, so that the cutting speed can be changed in relation to the amount of stock to be removed from the rods or to suit variations encountered in the machineability of the rods. Coolant is flushed over the broaches on the cutting stroke, shut off at the end of the stroke, and then again supplied on the return stroke, so as to wash away the chips.

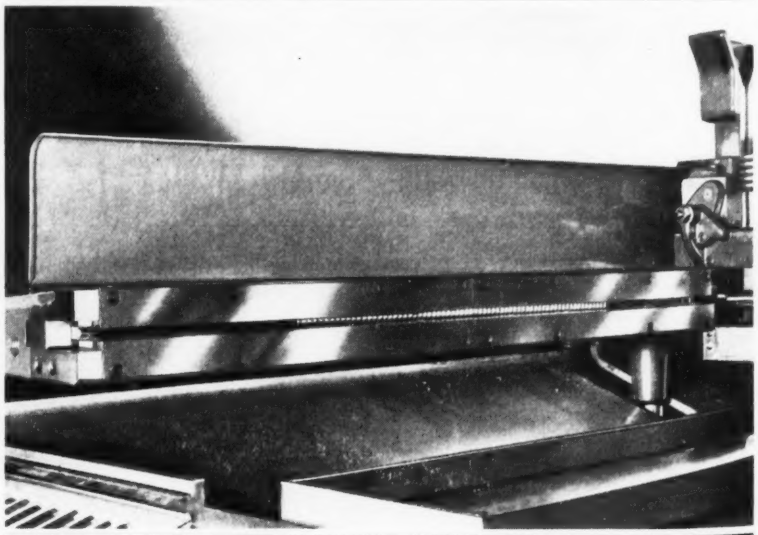


*Fig. 2. Close-up View of the Broach on One Side of the Machine along which the Seat-adjuster Rods are Carried by the Work Fixture. Six Hundred Rods are Finished an Hour*

## WEIGHT OF NON-FERROUS SHEET METAL, IN POUNDS PER SQUARE FOOT

| Thickness | | Yellow Brass* | Copper | Nickel Silver 18%-719† | Everdur 1010 |
|---|---|---|---|---|---|
| B&S Gage | Inches | | | | |
| 0000 | 0.4600 | 20.27 | 21.33 | 20.93 | 20.40 |
| 000 | 0.4096 | 18.05 | 18.99 | 18.64 | 18.17 |
| 00 | 0.3648 | 16.07 | 16.92 | 16.60 | 16.18 |
| 0 | 0.3249 | 14.32 | 15.06 | 14.78 | 14.41 |
| 1 | 0.2893 | 12.75 | 13.41 | 13.16 | 12.83 |
| 2 | 0.2576 | 11.35 | 11.94 | 11.72 | 11.43 |
| 3 | 0.2294 | 10.11 | 10.64 | 10.44 | 10.17 |
| 4 | 0.2043 | 9.002 | 9.473 | 9.296 | 9.061 |
| 5 | 0.1819 | 8.015 | 8.434 | 8.277 | 8.068 |
| 6 | 0.1620 | 7.138 | 7.512 | 7.372 | 7.185 |
| 7 | 0.1443 | 6.358 | 6.691 | 6.566 | 6.400 |
| 8 | 0.1285 | 5.662 | 5.958 | 5.847 | 5.699 |
| 9 | 0.1144 | 5.041 | 5.304 | 5.206 | 5.074 |
| 10 | 0.1019 | 4.490 | 4.725 | 4.637 | 4.519 |
| 11 | 0.0907 | 3.997 | 4.206 | 4.127 | 4.023 |
| 12 | 0.0808 | 3.560 | 3.747 | 3.677 | 3.584 |
| 13 | 0.0720 | 3.173 | 3.338 | 3.276 | 3.193 |
| 14 | 0.0641 | 2.825 | 2.972 | 2.917 | 2.843 |
| 15 | 0.0571 | 2.516 | 2.648 | 2.598 | 2.532 |
| 16 | 0.0508 | 2.238 | 2.355 | 2.312 | 2.253 |
| 17 | 0.0453 | 1.996 | 2.100 | 2.061 | 2.009 |
| 18 | 0.0403 | 1.776 | 1.869 | 1.834 | 1.787 |
| 19 | 0.0359 | 1.582 | 1.665 | 1.634 | 1.592 |
| 20 | 0.0320 | 1.410 | 1.484 | 1.456 | 1.419 |
| 21 | 0.0285 | 1.256 | 1.321 | 1.297 | 1.264 |
| 22 | 0.0254 | 1.119 | 1.178 | 1.156 | 1.127 |
| 23 | 0.0226 | 0.9958 | 1.048 | 1.028 | 1.002 |
| 24 | 0.0201 | 0.8857 | 0.9320 | 0.9146 | 0.8915 |
| 25 | 0.0179 | 0.7887 | 0.8300 | 0.8145 | 0.7939 |
| 26 | 0.0159 | 0.7006 | 0.7373 | 0.7235 | 0.7052 |
| 27 | 0.0142 | 0.6257 | 0.6584 | 0.6462 | 0.6298 |
| 28 | 0.0126 | 0.5552 | 0.5842 | 0.5734 | 0.5588 |
| 29 | 0.0113 | 0.4979 | 0.5240 | 0.5142 | 0.5012 |
| 30 | 0.0100 | 0.4406 | 0.4637 | 0.4550 | 0.4435 |
| 31 | 0.0089 | 0.3922 | 0.4127 | 0.4050 | 0.3947 |
| 32 | 0.0080 | 0.3525 | 0.3709 | 0.3640 | 0.3548 |
| 33 | 0.0071 | 0.3129 | 0.3292 | 0.3231 | 0.3149 |
| 34 | 0.0063 | 0.2776 | 0.2921 | 0.2867 | 0.2794 |
| 35 | 0.0056 | 0.2468 | 0.2597 | 0.2548 | 0.2484 |
| 36 | 0.0050 | 0.2203 | 0.2318 | 0.2275 | 0.2218 |
| 37 | 0.0045 | 0.1983 | 0.2087 | 0.2048 | 0.1996 |
| 38 | 0.0040 | 0.1763 | 0.1855 | 0.1820 | 0.1774 |
| 39 | 0.0035 | 0.1542 | 0.1623 | 0.1593 | 0.1552 |
| 40 | 0.0031 | 0.1366 | 0.1437 | 0.1411 | 0.1375 |

*Multiply weights in this column by 0.9935 for Tobin bronze; and by 1.0458 for 5 per cent phosphor-bronze - 351.
†Multiply weights in this column by 0.9905 for 10 per cent nickel silver - 752; by 0.9937 for 15 per cent nickel silver - 739; and by 1.0127 for 20 or 30 per cent Ambrac.
(Small variations from these weights must be expected in practice).

MACHINERY'S Data Sheet No. 343, New Series, April, 1937

Compiled by The American Brass Co., Waterbury, Conn.

## DATA ON HARD-FACING MATERIALS

| Material | Estimated Normal Life Compared to Best Steel | Surface Covered with 1 Lb. of Rod (Approx.) | Weight of Material per Sq. In. of Surface | Rod Data: Diameter, Inches | Rod Data: Length, Inches | Rod Data: Inches of Rod per Pound |
|---|---|---|---|---|---|---|
| Haynes Stellite No. 1 | 3 to 10 times longer | 1/16-in. thick 50 sq. in.<br>1/8-in. thick 25 sq. in.<br>3/16-in. thick 16 sq. in.<br>1/4-in. thick 12 sq. in. | 1/16-in. thick 0.019 lb.<br>1/8-in. thick 0.039 lb.<br>3/16-in. thick 0.058 lb.<br>1/4-in. thick 0.078 lb. | 1/8<br>3/16<br>1/4<br>5/16<br>3/8 | 3 to 7<br>4 to 8<br>5 to 10<br>6 to 12<br>8 to 14 | 235<br>105<br>60<br>38<br>27 |
| Haynes Stellite No. 6 | 3 to 10 times longer | Same as Haynes Stellite No. 1 | Same as Haynes Stellite No. 1 | 3/16<br>1/4<br>5/16<br>3/8 | 4 to 8<br>5 to 10<br>6 to 12<br>8 to 14 | 105<br>60<br>38<br>27 |
| Haynes Stellite No. 12 | 3 to 10 times longer | Same as Haynes Stellite No. 1 | Same as Haynes Stellite No. 1 | 1/4<br>5/16<br>3/8 | 5 to 10<br>6 to 12<br>8 to 14 | 60<br>38<br>27 |
| Has-crome | Same to twice as long | 1/16-in. thick 54 sq. in.<br>1/8-in. thick 27 sq. in.<br>3/16-in. thick 18 sq. in.<br>1/4-in. thick 13 sq. in.<br>1/2-in. thick 6.5 sq. in. | 1/16-in. thick 0.018 lb.<br>1/8-in. thick 0.036 lb.<br>3/16-in. thick 0.054 lb.<br>1/4-in. thick 0.072 lb.<br>1/2-in. thick 0.144 lb. | 1/4<br>3/16 | 18 and 36<br>18 and 36 | 64<br>112 |
| Hay-stellite Inserts | 20 to 50 times longer | Size of Haystellite Inserts (see below) | | | | |

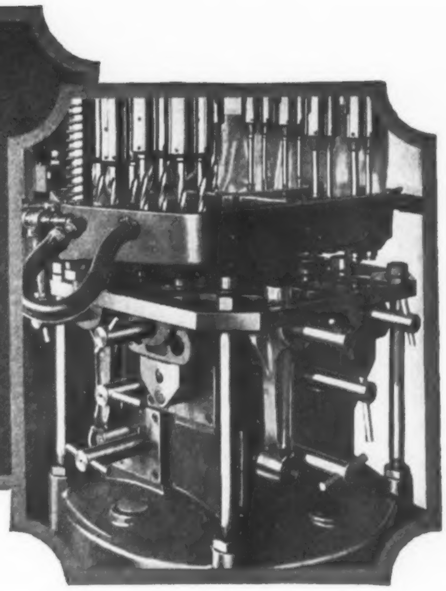
Size of Haystellite Inserts

| Size | Dimensions, Inches |
|---|---|
| 0 | 7/32 x 5/16 x (3/4 to 1 1/8) |
| 1 | 7/32 x 5/16 x (3/8 to 3/4) |
| 2 | 1/8 x 1/4 x (3/4 to 1 1/3) |
| 3 | 1/8 x 1/4 x (3/8 to 3/4) |
| 4 | 1/8 x 1/4 x (3/4 to 1 1/8) |
| 5 | 1/8 x 1/4 x (3/8 to 3/4) |
| 6 | 1/8 x 1/4 x (3/4 to 1 1/8) |
| 7 | 1/4 x 5/16 x (3/4 to 1 1/8) |
| 8 | 1/4 x 5/16 x (3/8 to 3/4) |
| 9 | 7/32 x 5/16 x (1 1/4 to 1 1/2) |
| 10 | 1/4 x 3/8 x (1 3/8 to 1 5/8) |

MACHINERY'S Data Sheet No. 344, New Series, April, 1937

Compiled by The Linde Air Products Co.

# Design of Tools and Fixtures

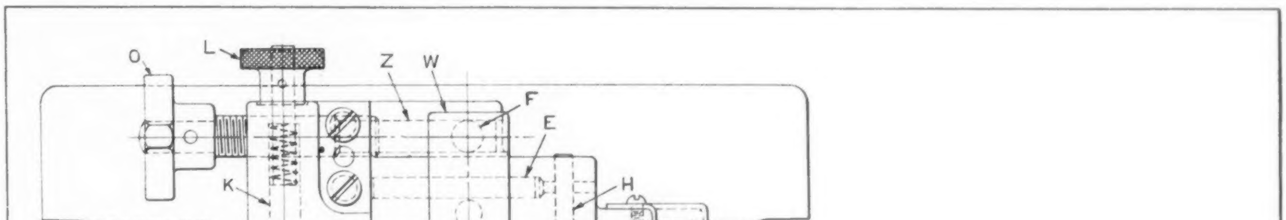


## Spring-Actuated Work Supports for Jigs

By F. SERVER

Variety in the design of spring-actuated supporting members is a feature of the fixture shown in the accompanying illustration. The work indicated by dot-and-dash lines at *X* has a thin structure on its left end in the form of two ribs, and a curved shape at the right end. The machining operation consists of milling the lug *Y* at the right end, using a forming cutter which travels from *A* to *B* across the upper end of the work.

Two holes *C* and *D* are used for locating pur-

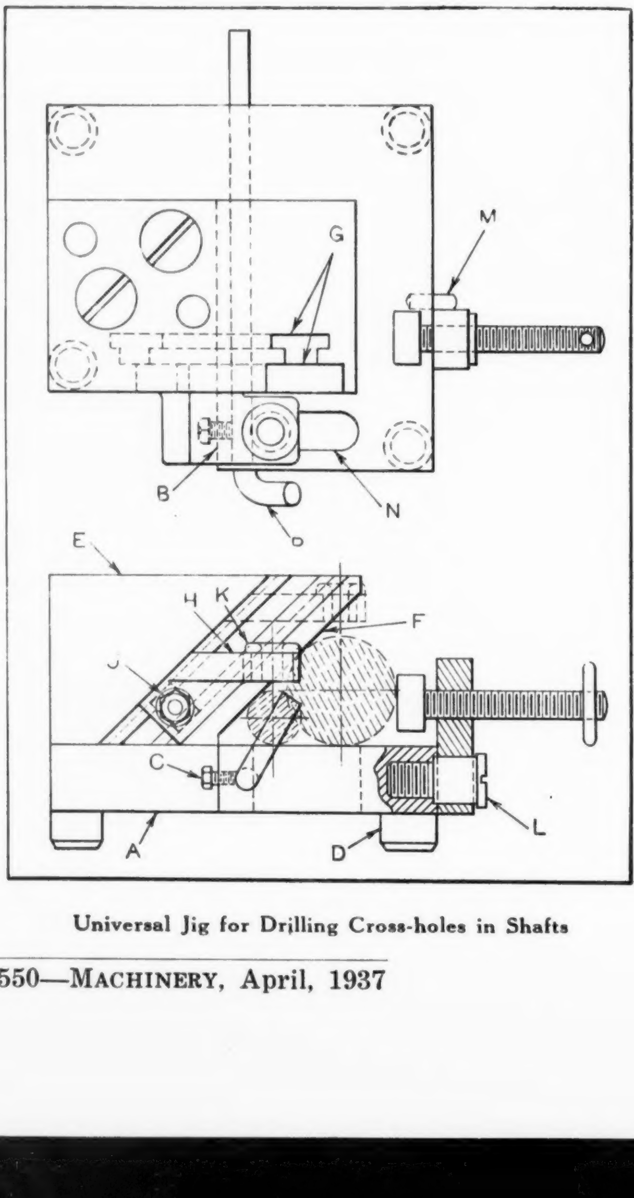



Fixture with Spring-actuated Supports for Slender Part

poses. A hardened block $G$ locates the work $X$ in one plane. In putting the work in the fixture, the hole at $D$ fits over the pin $H$, with the left-hand end of the work swung upward to clear the block at $J$. At this time, the operator holds back the spring pin $K$ by means of the knob $L$. Pin $K$ is allowed to enter the hole at $C$, and the formed channel at $M$ locates the work sidewise. The clamping members are shown in the working positions.

The block $N$ with the V-notch machined in its upper end is next allowed to come in contact with the boss of the work below the surface to be milled, a spring $P$ providing sufficient pressure to insure proper contact with the work. Tightening of the knob $Q$ serves to hold this end of the work securely, while a lug at $R$ is provided to facilitate hand operation of the block in its slide. The spring-actuated pin $S$ is next allowed to rise and make contact with the lower edge of the work. After clamping pin $S$ in place by means of the screw $T$, which acts on the beveled shoe $V$, the work is clamped over the central rib by the swinging clamp $W$, which is hinged on a pin at $E$.

A plunger $F$ having a beveled end is next brought to bear against the under side of the clamp. Another beveled plunger $Z$ is forced by the screw and knob $O$ against plunger $F$, causing the clamp to be swung over and grip the work. A spring plunger $I$ is provided for raising the clamp a sufficient amount to permit removing the work.



Universal Jig for Drilling Cross-holes in Shafts

In designing this fixture, no attempt has been made to incorporate quick-acting devices, it being considered of far greater importance to provide means for supporting the frail part with sufficient rigidity to insure accurate machining.

## Universal Jig for Drilling Cross-Holes Through Shafts and Studs

By JOHN A. HONEGGER, Bloomfield, N. J.

In the average machine shop many different sizes of holes are drilled crosswise through shafts and studs of different diameters. If small lots of pieces are to be drilled in this way, a jig having a wide range of adjustability, like the one shown in the accompanying illustration, is advantageous. The two cross-sectioned circles, the smaller of which is 1/2 inch and the larger 1 inch in diameter, indicate the range of sizes that can be drilled. The jig will accommodate work of even larger or smaller diameter than that indicated.

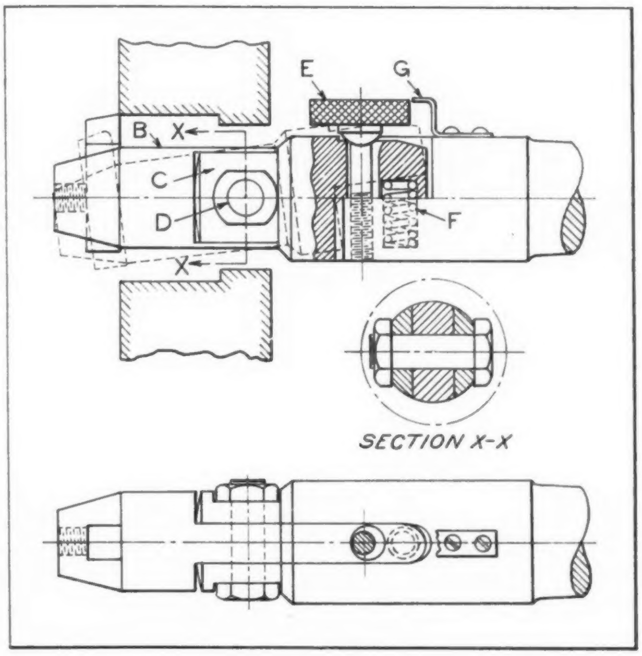
The drill jig has a baseplate $A$ which is cut away at $B$ to allow the clamping screw $C$ for stop $P$ to be located as shown. Four hardened steel legs $D$ of the button type are pressed into plate $A$. The block $E$ has a chamfered surface at $F$ which forms an angle of 45 degrees with the top of the baseplate $A$. Along the side of block $E$ and parallel to the 45-degree surface are a slot and a T-slot $G$. In this slot is fitted the hardened steel drill plate $H$, which can be clamped in any desired position by the nut $J$ on the T-bolt. Bushings $K$ for drills of different sizes can be inserted in the holder.

In the particular jig shown, a swinging latch type of clamp screw is employed, but a rigid type can be used if desired. The stud $L$ is embedded in plate $A$ to obtain strength, and the pin $M$ acts as a stop for the latch. An elongated slot at $N$ assures clearance for drills of various diameters. The adjustable end-stop $P$ can be swung inward or downward to accommodate work of different diameters, and can be adjusted through a distance of 6 inches for spacing or positioning the drilled holes. A second drill plate can also be mounted on the opposite end of block $E$ to permit drilling holes on either side of the block.

## Adjustable Boring-Bar for Counterboring Operation

By R. C. PEARSE, Montreal, Canada

The boring-bar shown in the accompanying illustration was designed to overcome difficulties experienced in accurately counterboring a series of holes in a gear-case. The surface counterbored was on the inside of the gear-case, and the counter-




Tool for Counterboring Series of Holes in a Gear-case

boring operation had to be performed with a tool that would pass through a hole 1/2 inch smaller in diameter than the counterbore. One of the main difficulties was to measure the counterbore after a cut had been taken. To do this, the tool had to be deflected sufficiently to allow the bar and the tool to be withdrawn through the small hole. A hand-hole in the gear-case permitted the diameter of the counterbore to be measured by an inside micrometer, after which the boring tool was returned to its former position.

The bar shown served this purpose very effectively, and in addition made it possible to accurately set the cutting tool so that it would remove exactly the amount of metal required to bring the hole to size, thereby eliminating the usual trial-and-error method.

The tool-holder portion of the bar *B* is provided with a fulcrum at *D* and is a close sliding fit in the shank part of the bar *C*. The fulcrum *D* consists of a turned bolt having a fine thread and a close-fitting nut. The adjusting screw *E* is tapped into the main part of the bar *C*, clear of the tilting part *B*. A spring *F* opposes the screw *E*.

To depress the tool, screw *E* is unscrewed. The head of this screw is graduated into sixty divisions, each division representing a movement of approximately 0.001 inch at the point of the tool. An indicator *G* is fastened to the main part of the boring-bar for use in returning the screw *E* to its exact original position.

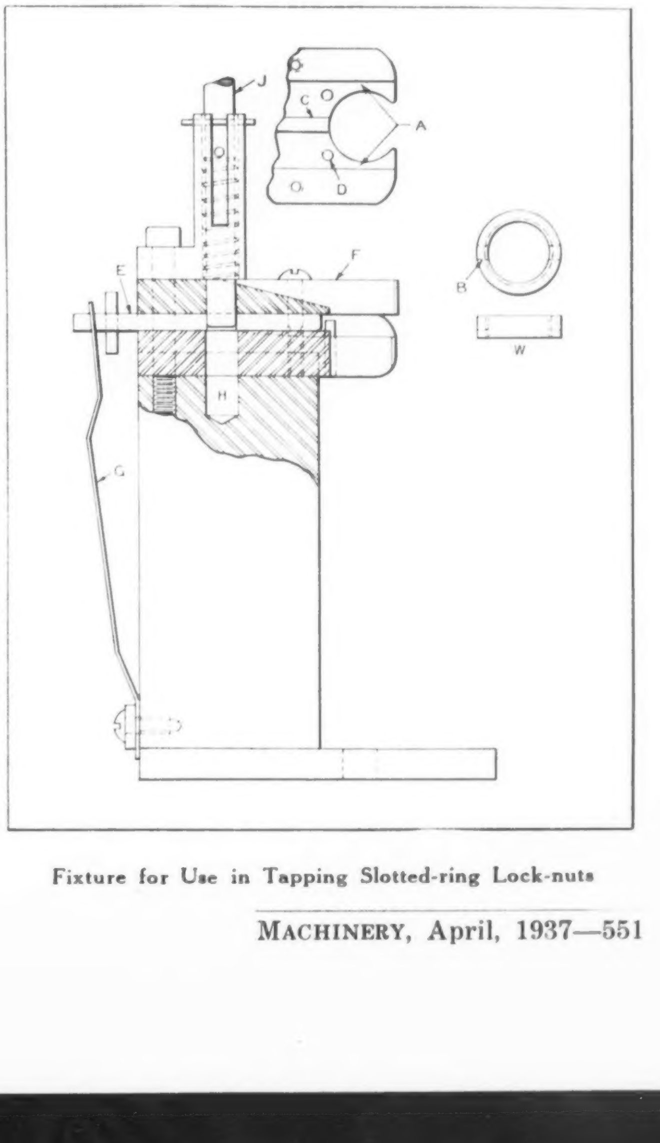
The tool was so designed that the thrust resulting from the cutting action was taken by the screw without affecting the spring. Although this tool proved to be extremely rigid in operation, it was found more practical to rough-bore the hole with a solid bar, and use the adjustable boring-bar for the finishing operation only.

## Lock-Nut Tapping Fixture with Safety Feature

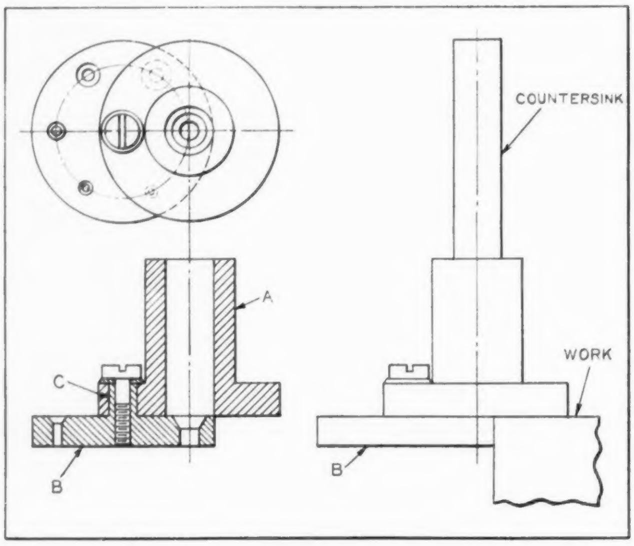
By H. GOLDBERG, Vice-President
R. G. Haskins Co., Chicago, Ill.

The fixture shown in the accompanying illustration is designed for use in tapping slotted-ring lock-nuts like the one shown at *W*. The nut blank is placed in the opening *A* with the slotted end down. The slot *B* fits over the tongue *C* and the blank is pushed against the two stop-pins *D*. The tongue prevents the nut from turning while being tapped.

A safety device is incorporated in the fixture which serves a double purpose, acting as a safety latch to prevent the operator from starting the tap unless the blank is in the proper position, and as a means of kicking the blank out of the fixture after it is tapped. The slide strip *E* is held down by the stripper plate *F* and slides forward into the groove *A* under the tension of the flat spring *G*. When the nut blank is placed in the fixture, it pushes slide *E* back, so that the hole in the slide lines up with hole *H*, as shown in the illustration. This permits the plunger *J* to be moved down to the lowest position. If the slide *E* is not pushed back far enough, plunger *J* will be prevented from entering the hole in slide *E* and it will be impossible to raise the tapping fixture or lower the tapping machine spindle a sufficient distance to permit the nut to be tapped.




Fixture for Use in Tapping Slotted-ring Lock-nuts




Countersink Setting Gage

## Gage for Setting Countersink to Correct Depth

By F. MUIR, Hamilton, Ont., Canada

Holes that are countersunk too deep or too shallow for screw-heads spoil the appearance of the work. The usual cut-and-try method of setting a countersink often results in countersinking some of the holes too deep before the machine is properly set. A gage for setting a countersink, similar to the one shown, will eliminate this trouble and enable the user to set the machine in a moment. It is used with a countersink which can be set to suit six or eight different sizes of flat-head screws.

The body *A* of the gage is reamed to suit the countersink and is mounted on the bearing *C* turned on base *B*. A screw and washer serve to hold the two parts together with a turning fit. Part *B* is drilled and countersunk to suit the various sizes of screw-heads within the capacity of the countersink.

To use the tool, part *B* is turned to bring the desired countersunk hole in line with the reamed hole in *A*. The tool is then placed on the surface of the work with *B* up against the edge, as shown in the view to the right. The countersink is now brought down and held in position while the stop of the drill press is clamped in place.

---

## Lever-Released Clamp and Locating Wedges

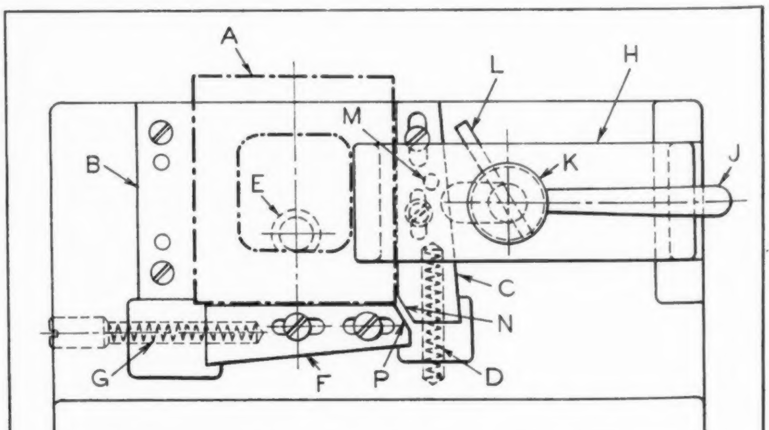
The work shown at *A* in the accompanying illustration is located against a steel plate at *B* by the wedge *C*, which is forced into place by a spring *D*. Inside of the work at *E* is a pin, one side of which is flattened for locating the work. A wedge *F*, actuated by spring *G*, forces the work against pin *E*. Thus the work is properly located in both directions. A clamp *H* is provided for holding the work in place. This clamp is tightened by means of the handle *J*, attached to the clamping screw *K*, the clamp being slid over or off the work by hand.

In the head of screw *K* is a pin *L* which comes in contact with pin *M* in wedge *C* when screw *K* is turned to the left, or counterclockwise. This movement withdraws the wedge from contact with the work. As wedge *C* is withdrawn, the beveled end at *N* strikes the beveled end *P* of wedge *F*, withdrawing it also from the work. Thus, a single movement of lever *J* serves to withdraw both locating wedges. The work is then removed and replaced by a new piece and the clamp is slid into place again. One movement of lever *J* permits the spring-operated wedges to force the work into place, where it is held by clamp *H*. H. M.

* * *

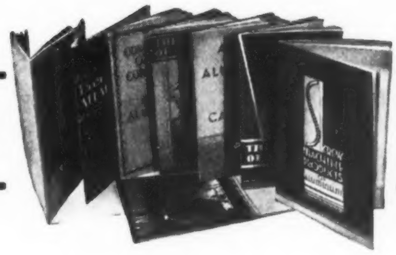
## General Electric Co. Makes Awards to Employes

Sophia Baikusis, a widow with two small children, started work in the General Electric plant at Schenectady twelve years ago, following the death of her husband. Today she has been honored with a Charles A. Coffin Foundation award, the highest honor the General Electric Co. bestows upon any of its employes. She has offered no less than eighty-nine suggestions for improved manufacturing methods, and fifty-four of them have been accepted. For each of the accepted suggestions, Mrs. Baikusis received a cash award under the company's suggestion system; and for being the company's best woman suggestor, she has now received the Coffin award. She is one of thirty-three employes who have just received such awards.




Fixture with Spring-operated Work-locating Wedges

# NEW TRADE LITERATURE



***Recent Publications on Machine Shop Equipment, Unit Parts, and Materials. Copies can be Obtained by Writing Directly to the Manufacturer***

### Springs

BARNES-GIBSON-RAYMOND DIVISION of ASSOCIATED SPRING CORPORATION, 6400 Miller Ave., Detroit, Mich. Practical handbook of modern spring engineering for users and designers of springs, entitled "The Art and Science of Spring Making," covering 88 pages, 8 1/2 by 11 inches, and containing a great deal of information about spring selection and design, most of it published for the first time. In addition to discussing the characteristics of many types of springs, numerous problems in design are actually worked out to show the use of the formulas. The subject matter is conveniently grouped for reference and well indexed to form a valuable guide for those buying and designing springs.

### Heat-Treating Equipment

LEEDS & NORTHRUP CO., 4921 Stenton Ave., Philadelphia, Pa. Six bulletins entitled: "Quench Direct from Temperature of Work Itself as Detected by Rayotube;" "Sensitivity is Higher, Costs are Lower when Rayotube-Micromax Controls High-Temperature Furnaces;" "No More Broken Thermo-couples in Forge Shops which Use Rayotube;" "No More Contamination of Couples in Controlled Atmospheres with Rayotube;" "Response is Speeded, Costs are Lowered when Rayotube-Micromax Measures Billet-Furnace Temperatures;" "Response is Speeded, Costs are Lowered when Rayotube-Micromax Measures Slab-Furnace Temperatures."

### Bronze Bearings

JOHNSON BRONZE CO., 520 S. Mill St., New Castle, Pa. Bulletin 370, listing over one hundred additional general-purpose bearing sizes, making the total number of sizes now available from stock over seven hundred. The catalogue also contains important sections on bronze cored and solid bars, hexagon bars, lead-base and tin-base babbitt, and graphited bronze bearings.

### Gears and Speed Reducers

CHARLES BOND CO., 617 Arch St., Philadelphia, Pa. Catalogue 58, covering stock gears, sprockets, speed reducers, and flexible couplings. The catalogue, containing 176 pages, gives specifications, prices, and directions for ordering. Booklet GA-48, covering speed reducers of fourteen different types, with ratios ranging from 5 to 1 to 2500 to 1.

### Die-Castings

NEW JERSEY ZINC CO., 160 Front St., New York City. Publication entitled "Die-Castings in Automotive Applications," containing a comprehensive paper on the subject, covering sixteen 9- by 12-inch pages, which was presented by C. R. Maxon before the Detroit Section of the Society of Automotive Engineers at the March 1 meeting.

### Synthetic Rubber

E. I. DU PONT DE NEMOURS & CO., Wilmington, Del. Booklet entitled "The Story of Neoprene—Its Discovery, Commercial Development, and Significance to Science and Industry." Neoprene is the generic term for synthetic chloroprene rubber and for products made from it by compounding it with appropriate vulcanizing agents.

### Ball Bearings

AUBURN BALL BEARING CO., 28 Industrial St., Rochester, N. Y. Catalogue 10, containing illustrated descriptions and engineering data pertaining to ball thrust bearings of single, double, and special types. The catalogue also covers radial ball bearings, cup and cone bearings, and mountings.

### Hydraulic Presses

HANNIFIN MFG. CO., 621-631 S. Kolmar Ave., Chicago, Ill. Bulletin 40, covering Hannifin hydraulic presses, and illustrating and describing representative types of equipment designed and built by the company to meet individual requirements of modern high-production manufacturing operations.

### Carboloy Grinding Chart

CARBOLOY COMPANY, INC., 2987 E. Jefferson Ave., Detroit, Mich. Wall chart, 18 by 12 inches, presenting in condensed form the most efficient methods for grinding single-point Carboloy tools. The chart contains recommendations for grinding wheels, wheel speeds, and grinding procedure.

### Hoists

HARNISCHFEGER CORPORATION, 4536 W. National Ave., Milwaukee, Wis. Bulletin entitled "P & H Hoists, No. H-5" illustrating over twenty-five industrial applications, and dealing with both general and specific problems in the industrial handling field. The bulletin lists ratings for hoists from 100-pound to 15-ton capacity.

### Copper Alloys

BRIDGEPORT BRASS CO., Bridgeport, Conn. First number of a monthly bulletin published primarily for technical and engineering men. The first (March) issue contains a digest of recent information and news of new developments of interest to industrial consumers of copper and copper alloys.

### Industrial Illumination

GENERAL ELECTRIC CO., Nela Park Engineering Dept., Cleveland, Ohio. Bulletin entitled "Lighting for Seeing in the Office," discussing the problem of lighting for casual seeing, for usual seeing, and for critical seeing. Recommended types of lighting equipment are shown.

### Lubricants

CONTINENTAL OIL CO., Dept. D, 60 E. 42nd St., New York City. Pub-

lication entitled "Modern Lubricants—X-Ray Diffraction Studies of Molecular Structures and Orientations, Including an X-Ray Method of Rating Lubricants in Terms of Protection against Surface Wear."

### Roller Bearings

HYATT BEARINGS DIVISION of GENERAL MOTORS CORPORATION, P. O. Box 476, Newark, N. J. Folder entitled "Hyatt Precision Bearings," illustrating and describing Hyatt Hy-Load solid roller radial bearings and Hyatt wound roller type bearings.

### Self-Locking Bolts and Nuts

DARDELET THREADLOCK CORPORATION, 55 Liberty St., New York City. Bulletin 16, on Dardelet self-locking bolts and nuts, describing the Dardelet self-locking screw thread and clearly explaining what it is, how it works, and what it does.

### Laboratory Equipment

C. J. TAGLIABUE MFG. CO., Park and Nostrand Aves., Brooklyn, N. Y. Catalogue 1100A, illustrating and describing thermometers and hydrometers for laboratory use. A very complete temperature scale conversion table is included.

### Electric Motor Service Bearings

JOHNSON BRONZE CO., 520 S. Mill St., New Castle, Pa. Bulletin EM-7, covering leaded phosphor-bronze electric motor service bearings. Cored, solid, and hexagon bronze bars, babbitt bearings, and general-purpose bearings are also included.

### Magnetic Relays

WARD LEONARD ELECTRIC CO., Mount Vernon, N. Y. Bulletin 81, listing more than one hundred relays for intermediate duty (10 to 15 amperes) on direct-current and alternating-current circuits for two- and three-wire control.

### Flow Meters

BROWN INSTRUMENT CO., Philadelphia, Pa. Catalogue covering indicating, recording, and integrating flow meters—electrical and mechanical. Unusually well illustrated descriptions of each type are included.

### Flexible Couplings

JOHN WALDRON CORPORATION, New Brunswick, N. J. Bulletin 53, illustrating and describing the new Francke fractional-horsepower flexible couplings. Complete price list is included.

### Arc-Welding Equipment

LINCOLN ELECTRIC CO., Cleveland, Ohio. Bulletin 318, covering Lincoln "Shield-Arc S A E" welder, engine-driven model, Type S-6005. Also bulletin 320, covering Type S-6018 welder.

### Temperature and Pressure Controllers

C. J. TAGLIABUE MFG. CO., Park and Nostrand Aves., Brooklyn, N. Y. Catalogue 900 C, covering non-indicating temperature and pressure controllers.

### Motor Controls

ELECTRIC CONTROLLER & MFG. CO., Cleveland, Ohio. Booklet 67, on EC & M steel-clad motor control, illustrating and describing various types of controls for a number of different industrial applications.

### Grinders

HAMMOND MACHINERY BUILDERS, INC., Kalamazoo, Mich. Bulletin 22, covering electric grinders with totally enclosed fan-cooled motors and belted grinders of bench and floor type.

### Lifting Chains

AMERICAN CHAIN DIVISION OF AMERICAN CHAIN & CABLE CO., INC., Bridgeport, Conn. Booklet containing standard sling chain specifications.

### Nickel Alloy Steel

INTERNATIONAL NICKEL CO., INC., 67 Wall St., New York City. Bulletin U-2, covering applications of nickel alloy steels in petroleum production equipment.

### Flexible Couplings

T. B. WOOD'S SONS CO., Chambersburg, Pa. Circular illustrating and describing Universal Giant flexible couplings, Type E, including dimensions and capacities.

### Switchboard Equipment

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin 2253A, entitled "Modern Switchboard Styling." Bulletin 2472, on automatic switchgear.

### Diesel Power Units

FAIRBANKS, MORSE & CO., 900 S. Wabash Ave., Chicago, Ill. Bulletin 3600-A1, illustrating and describing Model 36-A Diesel power units.

### Potentiometers

BRISTOL CO., Waterbury, Conn. Bulletin 482, descriptive of the new recording round-chart potentiometer known as the "Pyromaster."

### Dust Arresters

NORTHERN BLOWER CO., 6409 Barberton Ave., Cleveland, Ohio. Bulletin 163-1, on Norblo bag type dust arresters.

## The Lincoln Foundation Arc-Welding Prize Contest

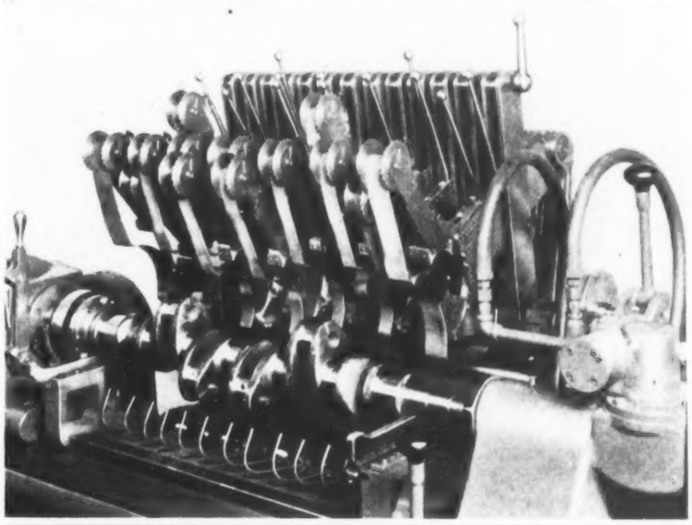
Additional information is available relating to the $200,000 arc-welding prize contest sponsored by the James F. Lincoln Arc Welding Foundation, referred to on page 475 of March MACHINERY. As will be remembered, in this contest 446 prizes totaling $200,000 are offered. The winner of the grand prize will receive $13,700.

The subject matter of the papers to be submitted has now been more fully defined. The papers may describe: (1) A redesign of an existing machine, structure, building, etc.; such machine, structure, or building would previously have been made in some other way; but in order that arc welding may be applied to its manufacture, it has been redesigned in whole or in part. (2) A new design of a machine, structure, building, etc., not previously made, which has been designed in whole or in part for manufacture or fabrication by the use of arc welding; the description must show how a useful result which was impracticable with other methods of construction could be better obtained through the use of arc welding; the machine, etc., need not have been manufactured or built at the time when the paper describing its design is submitted. (3) The organizing, developing, and conducting of a welding service, including commercial welders or job shops, garages, or service stations, or welding departments in plants building equipment of any kind. Note that the machine, etc., mentioned under (1) and (2) may be designed either in whole or in part for arc welding.

Complete information pertaining to the contest can be obtained from the secretary, James F. Lincoln Arc Welding Foundation, P. O. Box 5728, Cleveland, Ohio.

# *Shop Equipment News*

*Machine Tools, Unit Mechanisms, Machine Parts and Material-Handling Appliances Recently Placed on the Market*



## Norton Crankshaft and Camshaft Lapping Machines

Two new machines for lapping all the bearing surfaces of automotive crankshafts and camshafts have recently been developed by the Norton Co., Worcester, Mass. These machines have been named "Crank-O-Lap" and "Cam-O-Lap." The Type 30 "Crank-O-Lap," which is shown in Fig. 1 and in the heading illustration, is driven by a motor mounted on the base and connected to the headstock through a V-belt. It is also connected to a hydraulic pump by a flexible coupling.

The box-shaped base supports the work-table and a lapping arm frame. The table, in turn, supports the headstock, footstock, and work-rests. It is provided with hardened-steel V-shaped ways which bear on steel balls. As the table reciprocates when the work is being lapped, the balls minimize friction.

The lapping arm frame is pivoted and carries a bar to which guides are fastened for the arms, as well as a shaft for spools of strip abrasive paper. The lapping arms are jointed, so that they follow the pins of the crankshaft as it revolves. Take-up spools for winding the used abrasive strip are carried on the ends of the arms and operated by ratchets and pawls.

Actual lapping of each crankpin and bearing is accomplished by shoes which hold the abrasive strip firmly in place against the

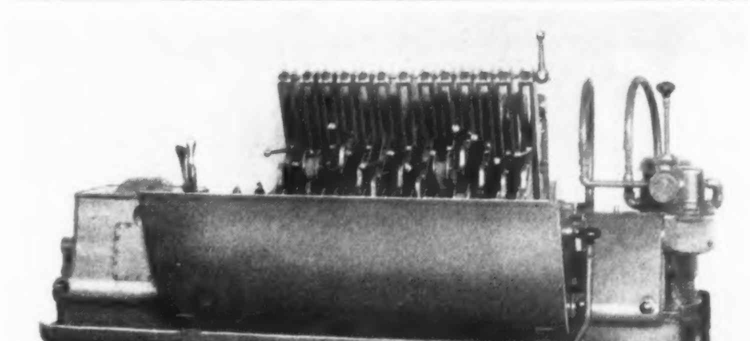



Fig. 1. Norton "Crank-O-Lap" for Lapping All Bearing Surfaces of Automobile Crankshafts

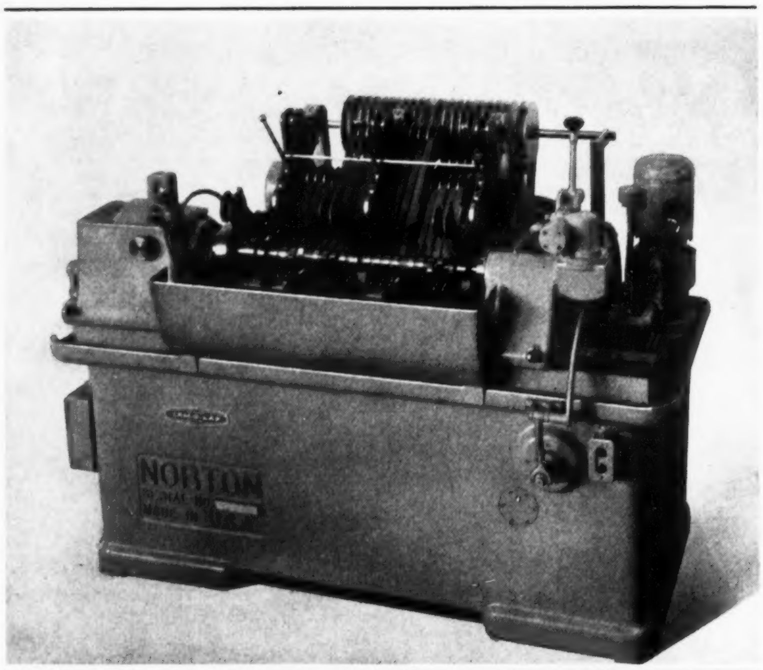



Fig. 2. Norton "Cam-O-Lap" for Lapping the Cam Contours and the Bearings of Automobile Camshafts

surfaces being lapped. These shoes are closed by means of levers. Lapping lubricant is automatically pumped on the work while it revolves. The heading illustration shows a crankshaft in the machine with the lapping arms in the back position.

The Type 30 "Cam-O-Lap," which is shown in Fig. 2, is supplied with the same base as the crankshaft machine. The machines are different, however, with respect to the application of the abrasive strips and the action of the lapping arms. In camshaft lapping operations, the unit pressure against the cam surfaces must remain constant. This is insured by providing a master cam for each cam lapping arm, to control the movements of the arms. The abrasive strips are held against the cams by shoes, the movement of which is controlled by the master cams.

The abrasive strips and supports are reciprocated rapidly in the direction of the axis on which the camshaft rotates and reciprocates. These motions result in the crossing and recrossing of the paths followed by the laps, and produce the degree of finish required.

A separate set of lapping arms identical with those used for crankshaft lapping is employed for lapping the camshaft bearings. The cam contours and the camshaft bearings are lapped simultaneously.

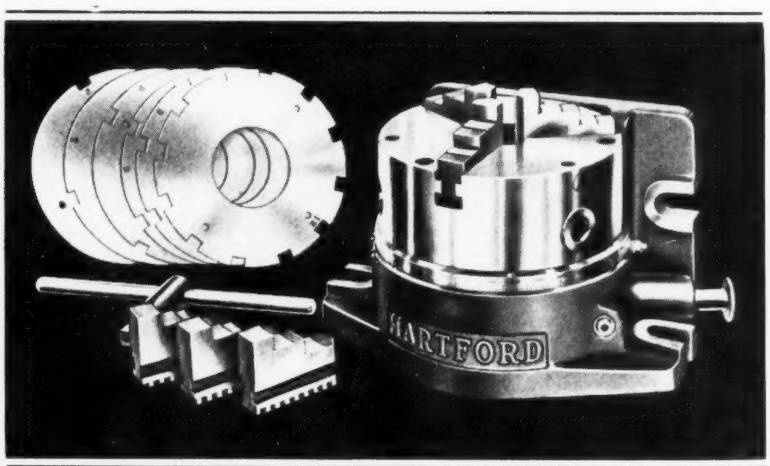
## Hartford "Super-Spacer"

An indexing chuck suitable for holding work horizontally or vertically on machine tools of various types is being introduced on the market by the Hartford Special Machinery Co., 293 Homestead Ave., Hartford, Conn. This "Super-Spacer," as the device is called, is fitted with a standard chuck body for holding work pieces rigidly either by means of universal or independent jaws, or by means of a fixture mounted on the chuck face.

Through the use of a master indexing plate having twenty-four accurately spaced notches, any of the following number of divisions are obtainable: 2, 3, 4, 6, 8, 12, and 24. Changes are readily made from one set of divisions to another by using mask plates notched with the desired number of spaces. These mask plates, which are seen at the upper left of the illustration, eliminate indexing errors because they permit engagement of only those notches that are left clear by the plate. Thus the mask plates facilitate the use of the "Super-Spacer" by an unskilled operator.

Indexing is rapidly accomplished by merely releasing a clamp, pulling a handle, and turning the chuck. The clamp secures the chuck solidly to the base for the performance of machining operations.

The device is suitable for use in milling, drilling, slotting, planing, and similar operations, and can be readily adapted for handling one piece or large quantities of work.



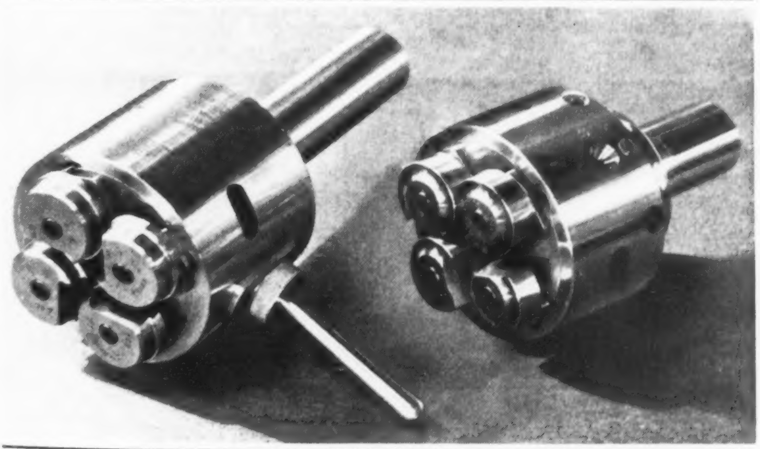

Hartford "Super-Spacer"—an Indexing Chuck or Work Fixture Applicable to a Variety of Machine Tools

## National Acme Hollow End-Milling Tool

The National Acme Co., 170 E. 131st St., Cleveland, Ohio, has developed a hollow end-milling tool designed to use circular cutters, which has the same micromatic adjustment and positive locking feature as the circular-chaser tools made by the concern. It will be seen from the illustration that by providing more than one step on the cutters, it is possible to turn work to several diameters with one pass. The cutters can also be used for facing or for machining to a radius at a shoulder, if desired. After the tool has completed the cut, the cutters are automatically released and backed off without marring the work.

Adjustment for diameter is provided in the tool. The cutters are sharpened in much the same way as ordinary cutters, but after being sharpened, they are set by means of a micrometer gage to insure even distribution of the cut.

The same tool-holder can also be used as a standard self-opening automatic die-head by simply changing from hollow milling cutters to circular chasers. In fact, a combination of milling cutters and circular chasers can be used. Work diameters ranging from 0.056 inch to 13 3/8 inches can be end-turned by the use of standard cutters.



Hollow End-milling Tool with Circular Form Cutters, Brought out by the National Acme Co.

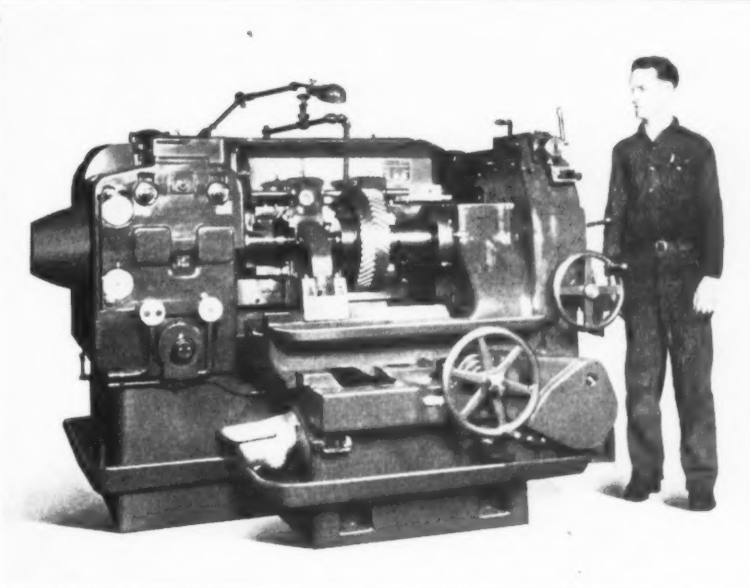


Fig. 1. Sykes Gear Generator which will Cut Spline Shafts, Cams, and Cylindrical Surfaces, in Addition to Gears

## Sykes Gear-Generating Machine for Limited or Quantity Production

A Sykes gear-generating machine that is equally suitable for tool-room work, general jobbing applications, and line production is being introduced on the market by the Farrel-Birmingham Co., Inc., 344 Vulcan St., Buffalo, N. Y. This machine will cut every type of gear used for connecting parallel shafts, including the Sykes double-helical continuous-tooth gears having sharp apices, single helical gears with angles up to 50 degrees, and straight-tooth gears. Internal as well as external gears can be cut.

Such operations can also be performed as cutting two members of a cluster gear simultaneously; machining cylindrical surfaces on shafts, pistons, etc.; cutting spline shafts, both parallel and tapered; and cutting some forms of cams. A quantity of gears mounted as a gang can be cut simultaneously. For instance, sixteen gear rings, each 1/2 inch wide, could be cut by eight cutters mounted in two gangs of four each. Each cutter will operate on two gears, so that the length of stroke is only slightly more than 1 inch. Plain disk cutters are used in machining the cylindrical surfaces of such parts as pistons and steering-gear shafts.

This No. 2-C machine has a maximum diameter capacity of 25 inches and a minimum diameter capacity of 1/4 inch. Helical teeth up to 3 diametral pitch and straight teeth up to 2 1/2 diametral pitch can be cut. The smallest tooth that can be machined is 24 diametral pitch. Face widths up

to 8 inches can be accommodated.

New features of the machine include locating the speed and feed controls at the front of the machine and embodying the speed and feed change-gears in one unit. All high-speed moving parts are force-lubricated, including the main reciprocating carriage, helical guides, cutter-heads, change-speed mechanism, change-gears, and crankpin and its sliding block.

The slide ways on the saddle for the outer bearing support consist of casehardened and ground inserts. The slide ways on the bed of the machine for the saddle are covered to protect them from grit and dirt. The coolant pump is driven by a separate motor and is of sufficient capacity to keep the cutters covered with coolant. The helical guides are of a new double-grooved type, with moving and fixed members that are approximately of the same length. The moving members are hardened and ground, while the fixed members are made of bronze and are easily adjusted for wear.

The cutter-heads embody a relief mechanism that insures positive relief of the cutters. When the cut is being taken, the mechanism that carries the cutters is locked rigidly to the cutter-head. All sliding surfaces in this mechanism, including the cutter-spindles and their bearings, are hardened to prevent wear.

An improved in-feed mechanism makes the machine entirely automatic, except for reloading. The machine is designed for operation at speeds as high as 400 revolutions per minute of the driving crank, which gives 800 cutting strokes a minute. It weighs 14,000 pounds, and occupies a floor space of 9 by 7 feet.

## Roller Cutter-Disk Grinding Attachment

A grinding attachment for resharpening cutter disks such as are used on the Geist roller pipe cutter is being introduced on the market by the Landis Machine Co., Inc., Waynesboro, Pa. This attachment can be applied to any Landis chaser-grinding machine by removing the steadyrest in front of the straight wheel, so that the attachment can be bolted to the machine bed. Disks 6, 7, or 8 inches in diameter can be ground with the attachment.

The cutter disk is mounted on the end of a shaft which is adjustable in a horizontal plane for obtaining any desired bevel on the cutting edge. A handwheel on the opposite end of the cutter-shaft permits revolving the disk against the face of the grinding wheel for grinding uniformly around the entire circumference. In-feed is accomplished by means of the hand-knob at the front of the attachment, and cross traverse through the handwheel at the left.

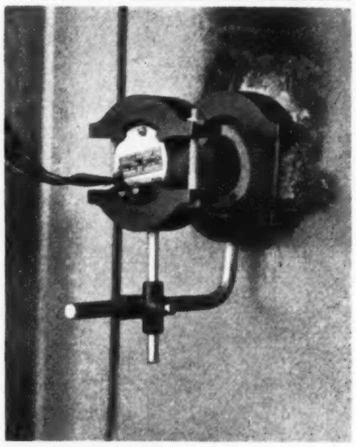


Fig. 1. Rayotube on Outside Furnace Wall for Detecting Inside Temperature

## Rayotube Temperature-Detecting Equipment

A temperature-detecting "Rayotube" that is mounted on the outside of the furnace away from the destructive heat to which ordinary thermo-couples are subjected has been made available by the Leeds & Northrup Co., 4921 Stenton Ave., Philadelphia, Pa. The principle of operation of this device is that a typical sample of heat is brought continuously to it. No protective covering is required, as the device is unaffected by gas, dirt, vibration, or careless handling.

An installation of a Rayotube on a furnace adjacent to a heavy

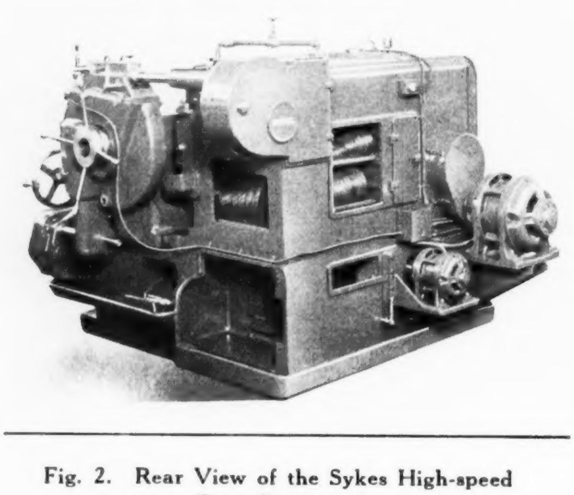
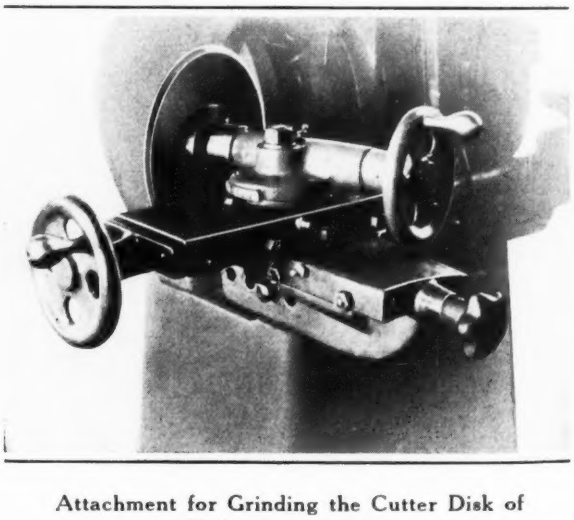


Fig. 2. Rear View of the Sykes High-speed Gear Generator



Attachment for Grinding the Cutter Disk of Roller Pipe Cutters

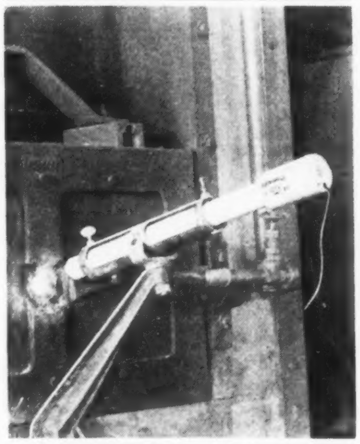


Fig. 2. Rayotube Detecting the Temperature of Work About to be Quenched

forging hammer is shown in Fig. 1. The instrument detects the internal temperature of the furnace from a cool outside location. The Rayotube "sights" through the open end of a target tube to the closed end which projects inside the furnace. This target tube is cemented in the furnace wall.

Two models of the Rayotube are available, a narrow-angle type which detects the temperature of small areas, and a wide-angle type designed for large-area temperature detection. The Rayotube seen in Fig. 1 is of the narrow-angle type, and the one in Fig. 2, of the wide-angle type.

The Rayotube shown in Fig. 2 is mounted at the discharge end of a continuous heat-treating furnace. It sights directly on the work as the latter is about to be quenched. Unlike ordinary thermo-couples, it detects the temperature of the work instead of the furnace temperature.

The Rayotube may be used with any standard Micromax recorder to indicate and record temperatures continuously. It can automatically operate signals or controls. In addition to heat-treating and forging furnaces, this device is applicable to such equipment as rotary kilns, bee-hive kilns, and slab and billet furnaces.

## Defiance Horizontal Two-Way Boring Machine

A horizontal two-way boring machine of heavy construction, designed for boring, facing, and counterboring opposite ends of pump casings and other large castings, has been brought out by the Defiance Machine Works, Defiance, Ohio. The spindle heads have independently controlled speeds and feeds. Each head is driven by V-belts from a motor mounted at the rear.

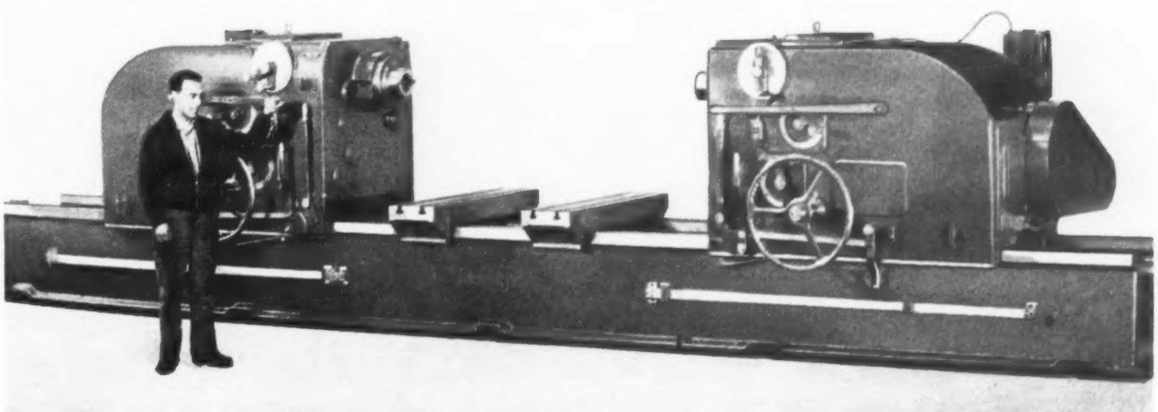
Twelve spindle speeds from 8 to 225 revolutions per minute are obtainable by sliding gears. Four feed changes ranging from 0.0078 to 0.0625 inch per revolution of the spindle are also available. Power rapid traverse and hand feed in either direction are provided.

The machine bed is 25 feet long and has ways with a maximum spread of 34 inches. The spindles are 5 inches in diameter and are mounted in Timken bearings. Each head has a movement of 6 feet on the bed, the maximum distance between the spindle noses being 12 feet. The two work platens can be positioned independently on the bed, in order to accommodate work fixtures.

## Syntron Semi-Portable Electric Hacksaw

A semi-portable hacksaw with a self-contained universal electric motor, which will operate from any 110-volt lamp socket, has been brought out by the Syntron Co., 400 N. Lexington Ave., Pittsburgh, Pa. Metal up to 5 by 5 inches can be cut with this machine, which uses 12-inch blades.

The material to be cut is held rigidly in a screw vise, the faces of which are machined to permit a true right-angle cut to be taken. Cuts at other angles can be made by clamping the material in a suitable position in the vise. The machine has a speed of 90 strokes per minute, the saw feeding into the material by gravity. Power to the motor is cut off automatically upon the completion of the cut. The base dimensions are 11 by 20 inches. The weight of the hacksaw is only 75 pounds.



Two-way Boring Machine for Heavy Work, Built by the Defiance Machine Works

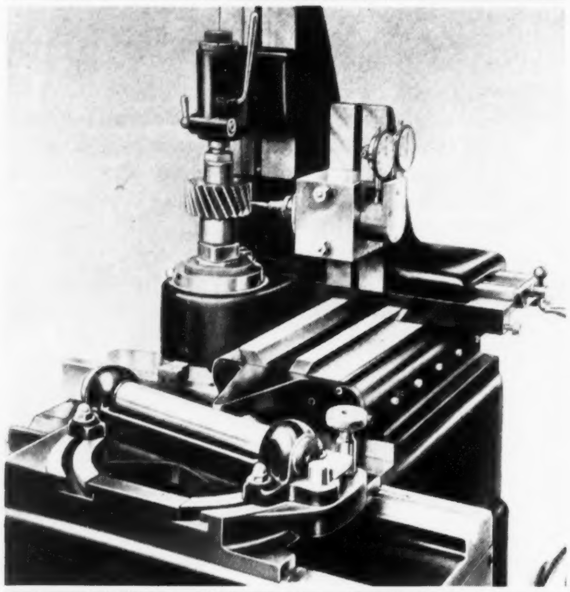


Fig. 1. Equipment Made by the Michigan Tool Co. for Checking Involute Form and Tooth Spacing

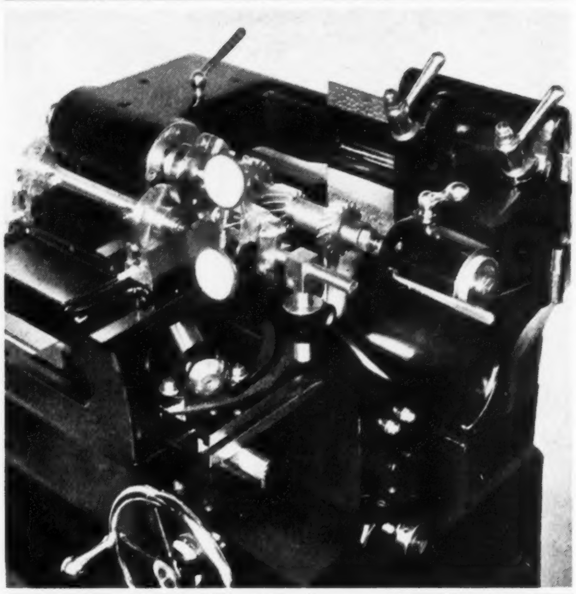


Fig. 2. Machine Designed for Checking the Lead of Spiral Gears up to 16 Inches in Diameter

## Michigan Tool Co.'s Gear-Checking Equipment

The line of gear-checking equipment of the Michigan Tool Co., Detroit, Mich., now includes a combined tooth-form and tooth-spacing checker, a spiral lead checker, and a hob-contour and worm-lead testing fixture, in addition to the gear speeder described in the May, 1936, issue of MACHINERY. Every piece of this equipment is provided with a sine bar, either for setting the machine or for use as a cam to procure a ratio of movement between two moving parts or to control the movement without the use of a lead-screw.

The combined tooth-form and tooth-spacing checker, illustrated in Fig. 1, is designed for rapid readings, and is readily adapted for making charts for comparison with other checking devices. The sine bar acts as a compensator for differences between the lengths of arc on the friction disk which originates the machine movements on the base circle of the gear being checked. Fig. 3 shows an inspection that determines tooth spacing and tooth form.

The friction disk is integral with the work-holding spindle and imparts movement to the sine-bar carriage. The angular setting of the sine bar controls the movement of the indicator head, the latter being counterweighted to hold it against the sine bar, as shown in Fig. 1. Each degree of work rotation is read on a scale that extends along one side of the sine-bar carriage.

Fig. 3. Combined Checking of Tooth Form and Spacing

The use of two indicators and a reversible finger makes possible the reading of tooth form on the front and back faces of a tooth in the same set-up. Gears up to 12 inches in diameter by 12 inches in length can be checked with this machine.

The spiral lead checker, shown in Fig. 2, takes right- or left-hand gears up to 16 inches in diameter, with leads of 6 inches or over. The sine bar is set to correspond with the correct spiral lead by means of two measuring buttons. The sine-bar carriage and the indicator are moved by means of the hand-wheel. A clevis that straddles the sine bar moves the upper carriage at right angles to the sine-bar carriage. The work-spindle is revolved by the friction of two lapped blocks on rolls. In this way, indicator movement and gear rotation are synchronized during checking. When the indicator is in contact with the gear tooth, any variation from the proper lead is shown on the indicator.

This gear-checking equipment is so designed that it is readily adapted for checking a large number of gears of the same characteristics or a small number of gears of widely varying designs.

## "Lo-Swing IMP" Lathe of Improved Design

The Seneca Falls Machine Co., 316 Falls St., Seneca Falls, N. Y., has recently brought out a new model of the "Lo-Swing IMP" lathe which retains the original basic features, but has been improved to give greater flexibility and economy of tooling and to enable full advantage to be taken of cemented-carbide tools. While the new model is intended primarily for machining work at high speeds to close limits of accuracy, it is also suitable for turning heavier work, such as small pistons, bushings, and gear blanks.

An extra long carriage bearing is obtained by a headstock construction that permits the carriage to slide under the headstock. Longitudinal movements of the carriage are effected by a drum cam. An end cover plate facilitates removal of this cam and permits timing the machine for automatic stopping and easy adjustment of the cams for the carriage cross-feed, when the latter is used. Feeds from 0.0005 to 0.050 inch are obtainable by means of pick-off gears.

The spindle is mounted in preloaded ball bearings and can be run at speeds up to 5000 revolutions per minute. Although the machine illustrated is equipped with a magnetic chuck for facing disks, either a lever- or an air-operated tailstock can be supplied for between-center work. The tailstock can be equipped with a quill carrying a built-in revolving center.

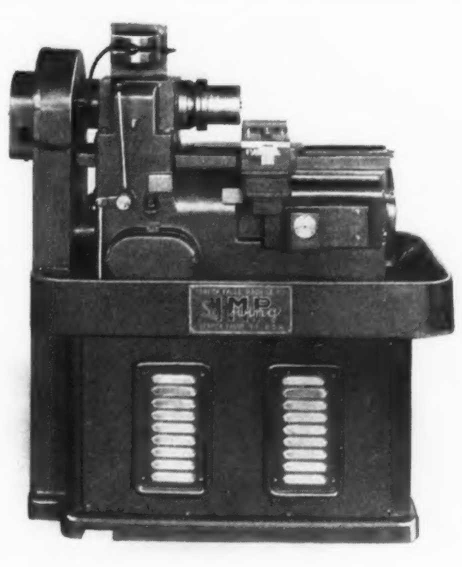
The machine weighs approximately 2000 pounds. It swings work up to 9 1/4 inches in diameter over the carriage and 4 inches in diameter over the cross-slide. Pieces 8 inches long can be held between centers.

## Covel Hydraulic Surface Grinder

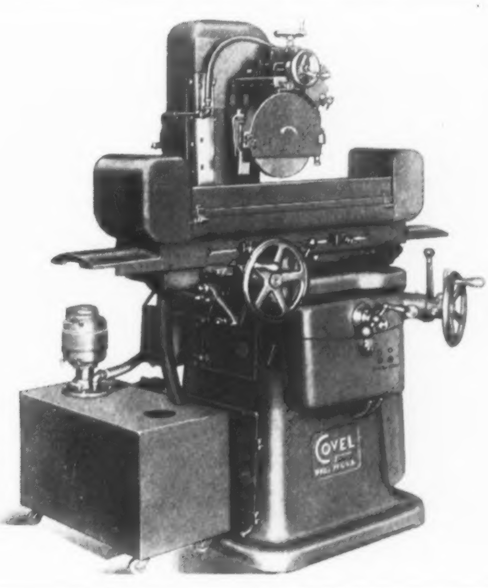
Table speeds variable from 10 to 90 feet a minute permit the use of hard free-cutting wheels on a No. 5 hydraulic surface grinder being introduced on the market by the Covel Mfg. Co., Benton Harbor, Mich. At the maximum speed, the table reverses without shock, even when grinding a heavy piece of work. The wheel-spindle is of the direct motor-driven cartridge type, the spindle and rotor being balanced as one unit. The wheel runs at 1750 revolutions per minute; however, a high-speed attachment can be supplied to give speeds of 4900 and 9700 revolutions per minute for driving 4- and 2-inch diameter wheels, respectively. A wheel truing device may be built into the head if desired.

This machine is provided with a patented double-elevating screw mechanism which insures accuracy in adjusting the grinding wheel vertically. A precision cross-feed facilitates grinding up to a shoulder. All wearing surfaces are protected from abrasive material; for instance, the elevating screws and nuts, as well as the vertical slides, are enclosed by telescoping guards, while the cross-feed adjustment mechanism is covered by a hinged guard.

The handwheel for positioning the grinding wheel is located at the work level of the machine and at the operator's right hand. With this arrangement, the operator can quickly sight the surface to be ground, in adjusting the wheel to the work, and can conveniently look down on the graduations around the rim of



"Lo-Swing IMP" Lathe which Embodies New Features of Construction



Covel Surface Grinder with Table Speeds from 10 to 90 Feet a Minute

the handwheel. The 0.0005-inch graduations on the handwheel rim of 5/32 inch apart. A ball-bearing throttle valve expedites changes in table speeds. The hydraulic pump, which actuates the table, is driven by a two-horsepower motor through V-belts.

Work up to 24 inches long, 8 inches wide, and 11 inches high can be ground under a 12-inch wheel. Removal of the dust guard affords an additional working height of 2 inches. The longitudinal movement of the table is 26 inches, and the cross traverse, 8 1/2 inches. The grinding wheel is 12 inches in diameter by 3/4 inch thick.

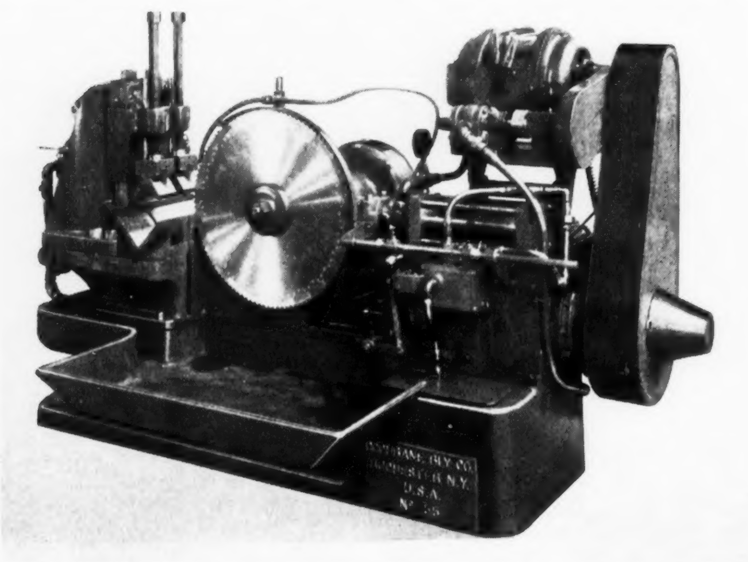
## Cochrane-Bly Hydraulic Cold Saw

Saw speeds from 235 to 600 feet a minute are obtainable with a hydraulic cold sawing machine recently developed by the Cochrane-Bly Co., Rochester, N. Y., for the rapid cutting of non-ferrous tubing and bars. Tubes up to 8 inches in diameter can be handled by the machine, the cutting time for tubes of this size being 8 seconds.

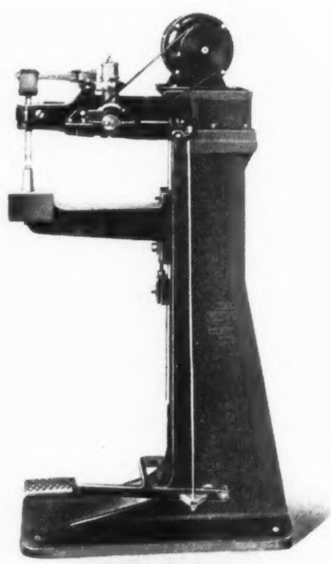
This high-speed machine has a four-speed sliding-gear transmission, operated through a remote control. All drive shafts, including the saw spindle, are mounted in anti-friction bearings. The hydraulic feed is adjustable from 0 to 60 inches a minute. There is an automatic trip and a rapid return of the carriage, as well as a rapid forward traverse. Adjustable stops regulate the travel of the carriage to suit the size of tubing being cut.

Another feature of the machine is a hydraulically operated vise having a compound toggle link and a vertical slide that brings adjustable clamping screws to each side of the saw blade. These screws are fitted with removable V-blocks or radius blocks that prevent distortion of thin-walled tubing under the clamping pressure.

The machine is motor-driven through multiple V-belts, and is equipped with a friction clutch for instantaneous starting and stopping. An extended pan provides large storage space for chips, and permits their convenient removal. The weight of this machine is 5000 pounds.



Cochrane-Bly Cold Saw which Cuts Non-ferrous Tubes and Bars at Saw Speeds up to 600 Feet a Minute



"High Speed" Riveting Hammer with 16-inch Throat

## "High Speed" Wide-Gap Riveting Hammer

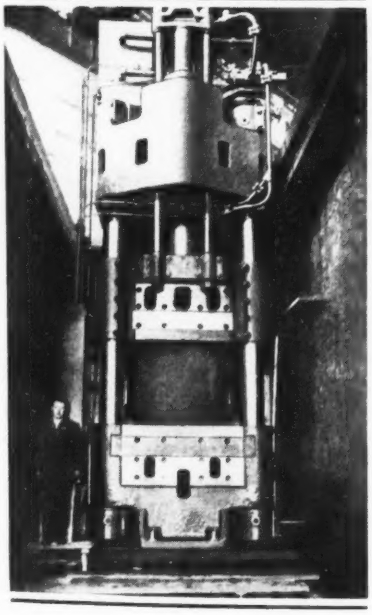
A series of wide-gap machines designed to accommodate work of large dimensions has been added to the line of riveting hammers manufactured by the High Speed Hammer Co., Inc., 333 Norton St., Rochester, N. Y. These wide-gap machines will handle such parts as snow shovels, blower fans, and impellers. Hub bushings can be readily riveted into place on fans. Wheels for toy carts and other circular parts having a radius that is smaller than the gap of the riveting hammer can also be handled conveniently.

The No. 2-A heavy-duty machine illustrated has a throat depth of 16 inches, but wide-gap machines are also available with throat depths of 12 and 14 inches. The motor is mounted directly above the column instead of on a shelf at the rear, and is driven through a V-belt. Aside from these features, the new machines are of the same construction as the standard High Speed riveting hammers, which have a throat depth of 6 inches. These machines are built in ten sizes for rivets up to 1 1/2 inches in diameter.

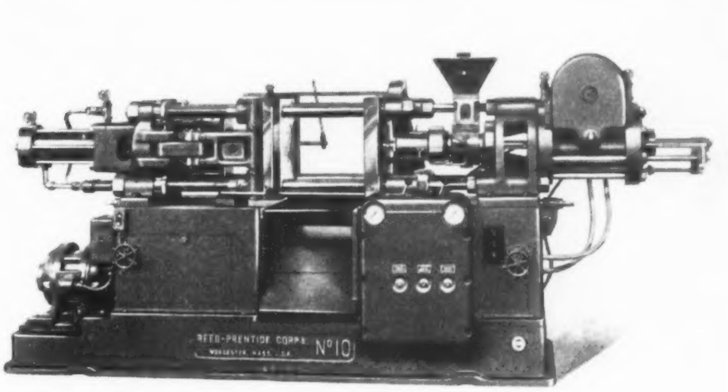
## Farrel-Birmingham 2000-Ton Forming Press

A huge self-contained metal forming press standing nearly 26 feet high and weighing 175 tons has been built by the Farrel-Birmingham Co., Inc., Ansonia, Conn., for the Lockheed Aircraft Corporation, Burbank, Calif., for use in blanking and forming duralumin aircraft parts. This forming press will exert a pressure of 2000 tons under a hydraulic pressure of 2300 pounds per square inch on one 38-inch ram and two 20-inch rams. While the maximum capacity of the press is 2000 tons, the pump control is so designed that a wide range of hydraulic pressures can be obtained.

The clear space available between the tie-rods is 61 inches by 97 inches. Both the moving platen and the bottom cross-head are provided with T-slots running the width of the press and with machined surfaces to which platen extensions can be added. The press is designed with a maximum opening of 60 inches and a maximum stroke of 36 inches. The closing and return speeds are 130 inches per minute, while the pressing speed ranges from 1 to 10 inches per minute.



Farrel-Birmingham Press for Forming Duralumin Aircraft Parts




Reed-Prentice Automatic Plastic Injection Molding Machine of Improved Design

## Reed-Prentice Improved Plastic Injection Molding Machine

A Model No. 10 automatic hydraulic plastic injection molding machine with several improved features has been brought out by the Reed-Prentice Corporation, Worcester, Mass., to supersede the model described in December, 1936, MACHINERY, page 280. In the new model, the five-horsepower driving motor and control for the hydraulic pump are mounted on the outside of the machine cabinet. This permits the use of a standard open type ball-bearing motor instead of the fan-cooled motor, provided on the original model of this molding machine.

The automatic timing control now consists of three units, which are adjustable from 1 to 120 seconds. One unit determines the time that pressure is applied to the plunger, another the period for solidification of the plastic material, and the third, the time that the molds are open for ejecting the product. When the machine is operated manually, it is controlled through two levers, one for closing the mold and the other for operating the injection cylinder.

The entire toggle end of the machine is adjustable through a screw which permits accurate set-up of molds and adjustments for different mold thicknesses. The injection-cylinder end of the machine is also adjustable to permit quick dismantling and changing of the heating unit, cleaning, and accurate positioning of the nozzle. The electric heating unit includes a rheostat, and provision is made for a thermometer or thermo-couple to accurately control the temperature of the material.

Die-plates can be supplied to suit requirements, and the distance between the die-plates can be made as great as 24 inches. There is a safety device and an automatic knock-out for the parts produced.

## Hammond Grinders with Totally Enclosed Fan-Cooled Motors

All the grinders of three horsepower and larger capacity made by Hammond Machinery Builders, Inc., 1600 Douglas Ave., Kalamazoo, Mich., are now equipped with totally enclosed fan-cooled motors. The rotor and stator are assembled in an enclosed chamber that is sealed against the entrance of all foreign matter. Two fans force cooling air around the outside of this chamber to carry away the heat of the motor. In general appearance, the grinders are the same as previous models described in MACHINERY.

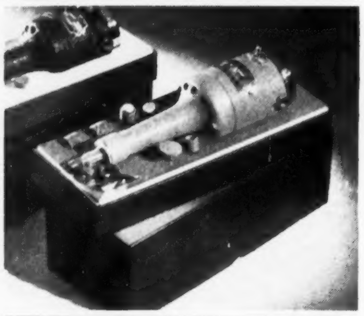


Fig. 1. Dumore Light-weight High-speed Grinder

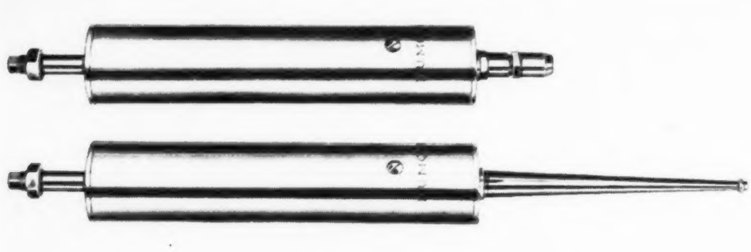


Fig. 2. Two Quills which Increase the Versatility of No. 7 Dumore Grinders

## Dumore High-Speed Grinder and Quills

A No. 10 hand grinder, driven by a 1/18-horsepower motor at a speed of 20,000 revolutions per minute, has been added to the standard grinder line of the Dumore Co., Racine, Wis. The tool is of light weight—2 pounds 12 ounces—having originally been designed for use in the production lines of automobile plants.

This grinder, which is illustrated in Fig. 1, is equipped with a 1/8-inch collet chuck. The construction includes grease-sealed precision ball bearings. Air for cooling purposes passes through a snap-on filter cap.

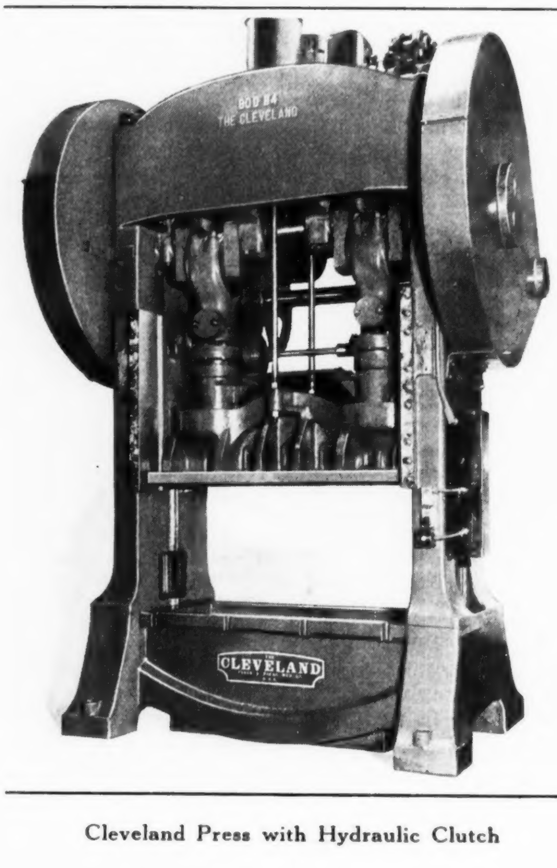
Both the No. 10 grinder and the No. 8 grinder are now packed in boxes covered with black leatherette. The grinders are mounted in colored inserts which also serve as holders for accessories. A locking device in the cover eliminates the necessity of further packing.

Three new quills are also being announced at this time for the No. 7 Dumore grinder. The P quill, seen in the upper part of Fig. 2, is equipped with a 1/4-inch chuck for mounted wheels, as well as a sleeve collet of 1/8-inch capacity. This quill is intended for grinding holes less than 1 inch in diameter and up to 1 1/4 inches deep.

The N-6 quill, shown at the bottom of Fig. 2, is capable of grinding a hole 11/16 inch in diameter to a depth of 6 inches and of grinding smaller hole diameters to correspondingly shorter depths. There is also an N-5 quill which is similar to the N-6, except that it has a maximum grinding depth of 5 inches. A fourth quill, known as the V-6, is also similar to the N-6. However, it is intended for use with the No. 5 grinder.

## Cleveland Press with Hydraulic Clutch

An electrically controlled hydraulic clutch with a four-station selector that facilitates momentary, long, continuous, and inching operations is a feature of the straight-sided double-crank press here illustrated. This machine was recently built by the Cleveland Punch & Shear Works Co., Cleveland, Ohio. The hydraulic clutch is so designed that when it is released, the oil is not exhausted or drawn out of the line, but is merely backed up sufficiently for the release. As a safety precaution, the brake is spring-loaded. In the event of a failure in any part of the hydraulic line, the clutch will be immediately disengaged and the brake applied to bring the press to a stop.




Cleveland Press with Hydraulic Clutch

This style of press can be furnished in a large number of sizes and can be equipped with other styles of clutches to suit individual requirements. The particular machine illustrated is arranged with a twin drive to

the crankshaft through herringbone gears that run in oil. An air counterbalance is provided for the slide, the latter being power-adjusted through an individual motor.

## Verson "Allsteel" Press and Press Brake

A new line of single-crank, full-eccentric front-to-back presses of the construction illustrated in Fig. 1, has recently been developed by the Allsteel Press Co., 12,023 S. Peoria St., Chicago, Ill. The principal feature of these presses is the elimination of the conventional crankshaft. The crank motion is obtained by means of an integral eccentric and gear that rotates the main shaft.

These presses can be equipped with either an air- or hydraulically-operated clutch and brake, thus insuring instantaneous and even-holding pressure. The pitman connection is of the barrel type, which keeps the adjustment screw vertical at all times. The ram is adjustable by means of a hoist type motor, and is counterbalanced by air cylinders in the columns.

The same company is also announcing five series of press brakes that comprise twenty standard sizes. Brakes that vary from standard dimensions can be supplied. One of these press brakes is shown in Fig. 2. It is built entirely of steel, heavy plate sections being welded to rigid members. The main bearings are located so as to absorb the load directly in the center of the main housing plates. The pitman connection is designed to reduce the bending moment on the adjusting screws to a minimum.

The bed of these press brakes is unusually deep, and is of two-plate construction, allowing slugs to fall through in gang punching operations. It rests on a round saddle in the housing. Another feature of the construction is that the elevating shaft is split and connected by means of a jaw coupling. This arrangement allows either side of the ram to be raised or lowered individually for realignment or to suit tapered work.

## General Electric Rotating-Cam Switches

A new line of rotating-cam switches, designed especially for built-in control applications and adaptable to a variety of electrical functions and machine requirements, has recently been placed on the market by the General Electric Co., Schenectady, N. Y. These devices are available with flanges for flush-mounting on machines and without flanges for non-built-in applications. A number of electrical and mechanical modifications make the switches suitable for applications varying from machine tool motor control to steel-mill master switching.

Two sizes of these switches are available, size 0, which is rated at 15 amperes continuous, and size 1, which is rated at 25 amperes continuous, both being intended for alternating current of 600 volts or less. There are four standard types for controlling (1) single-speed motors for reversing applications; (2) two-speed separate-winding motors for non-reversing applications or for one forward speed and one reverse speed; (3) two-speed

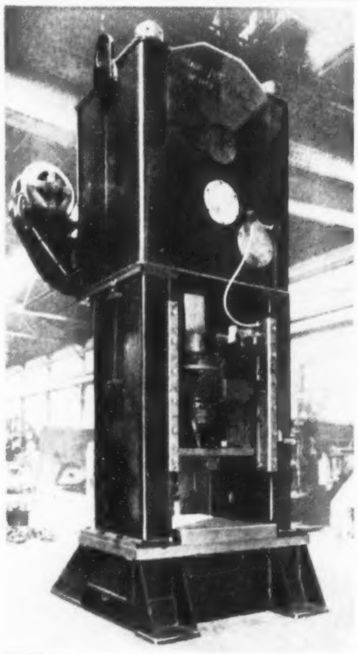


Fig. 1. Press with Eccentric instead of Customary Crankshaft

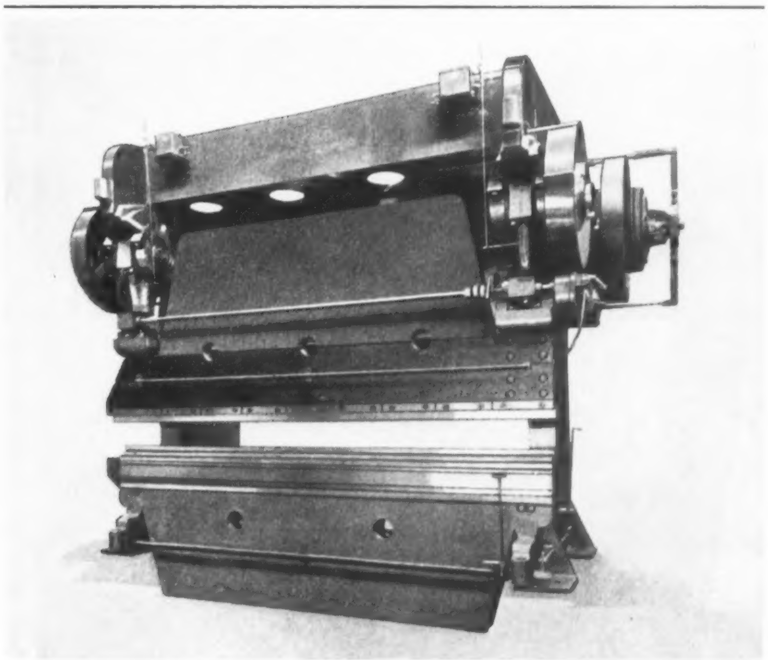


Fig. 2. Press Brake Constructed so that Either Side of the Ram can be Raised or Lowered Independently

single-winding motors for non-reversing applications or for one forward speed and one reverse speed; and (4) motors providing three or four forward speeds and one reverse speed. In addition, special sequences are obtainable, as well as switches with off-position contacts.

The flanges available for flush-mounting make it possible to build the switches into a machine by merely providing an opening and suitable holes. Since each switch is completely enclosed in a steel housing, even when mounted within a machine, the operator is safeguarded and the possibility of failure due to the accumulation of dirt is minimized. For service where switches are subjected to a large amount of non-explosive dust, covers can be supplied which have felt gaskets riveted around the edges.

## Keuffel & Esser Paragon Drafting Machine

A drafting machine in which parallel motion of the two scales is maintained by steel bands concealed within the aluminum-alloy arm sections, is being introduced on the market by the Keuffel & Esser Co., Adams and Third Sts., Hoboken, N. J. All moving parts of this Paragon drafting machine turn on precision ball bearings. The protractor head allows the scales to be set and locked at any angle, to move freely during angular displacement, or to stop automatically every 15 degrees. Variations in the angle of the scale settings are made by means of a mechanism operated by a lever under the left thumb of the draftsman.

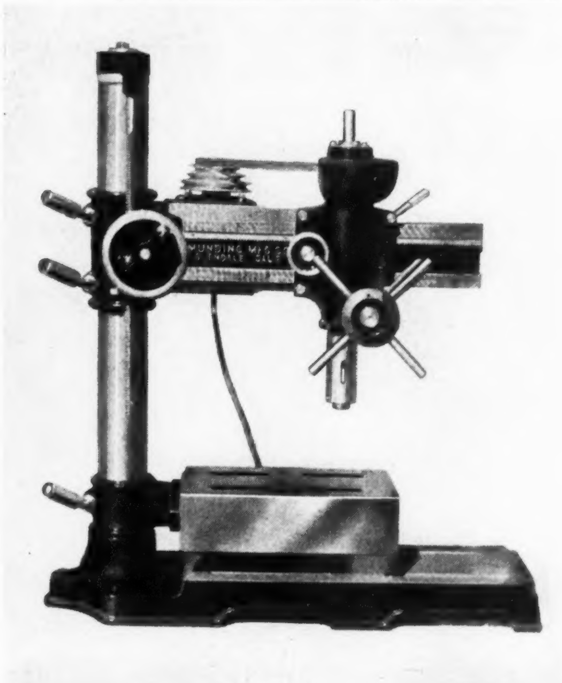
Scales can be quickly interchanged to permit the use of any required combination. In addition to the conventional white-edged scales, a series of special scales is available, made of aluminum alloy with a hardened black surface on which there are white graduations and numbers. These aluminum scales are impervious to atmospheric changes and resist wear and rough handling.

This drafting machine is available in two models, one of which can be held by a spring counterbalance at any angle up to 15 degrees. The other is equipped with a weighted counterbalance and can be used in any board position from the horizontal to the vertical.

## Munding Bench Type Radial Drilling Machine

The 40-inch bench type radial drilling machine built by the Munding Mfg. Co., 703 E. Colorado Blvd., Glendale, Calif., is capable of drilling small holes over an area greater than is possible with many larger machines. The equipment includes a table that can be tilted on its axis to any desired angle and clamped. The arm of the machine can be swung around on the column for operations on work placed in front of the bench.

K. & E. Drafting Machine with Parallel Motion of Scales Maintained by Steel Bands



Munding Bench Type Radial Drilling Machine of 40 Inches Capacity

There is a simple method of changing the driving belt. By pulling a knob at the back of the arm, the motor is moved toward the end of the arm, so as to reduce the distance between the driving and driven pulleys. The belt can then be easily shifted from one pulley groove to another. Belt stretch can also be taken up through an adjustment afforded by this arrangement of the pulleys.

The machine has a capacity for drilling holes up to 1/2 inch at the end of the arm. It is driven by a motor of 1/3 horsepower. The length of the base is 36 inches, and the height of the column, 38 inches. The spindle speeds are 750, 1500, 2250, and 3000 revolutions per minute.

## Do-All Machine with Saw Speed Selector

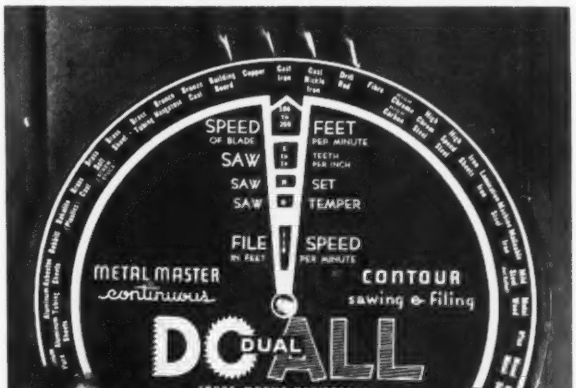
In sawing dies and other parts to the required contours with the narrow band saw of the Do-All machines, built by Continental Machine Specialties, Inc., 1301 S. Washington Ave., Minneapolis, Minn., an important factor is to run the saw at the proper speed for the material being cut. For instance, in cutting high-chromium high-carbon steel, the saw should travel from 50 to 75 feet a minute, whereas in cutting aluminum, the saw should travel from 400 to 500 feet a minute. Different thicknesses of work should also govern the sawing speed. The same is true in filing or polishing on the Do-All machine.

The concern has recently developed a contour machine equipped with a dial that shows the proper saw speed to be used for forty-eight different materials. This machine is similar in appearance to the model described in November, 1936, MACHINERY, page 220, except that the upper pulley is covered by a hinged door on which the control dial is installed. The various materials are listed in alphabetical order around the dial, beginning with aluminum and ending with zinc. The list includes several trade-marked materials, as well as all the common metals and materials.

In addition to the proper saw speeds, the dial also shows the correct saw pitch, temper, and set for each of the forty-eight different materials. The new machine is equipped with an improved lap grinder, has a wider saw-guide adjustment than previous models, and is of heavier construction throughout.

## Light Grinding Machines and Vertical Angle-Plate Grinders

The Standard Electrical Tool Co., 1948 W. Eighth St., Cincinnati, Ohio, has developed a line of light-weight grinding machines which includes models of 3-, 5-, and 7 1/2-horsepower capacities. Power is transmitted from self-contained motors through V-belts to the grinding spindle. The column is of the overhanging type, which permits the handling of bulky work with minimum interference. Space is conserved by mounting the ball-bearing motor and its magnetic starter inside the base. A screw at the back of the machine permits raising and lowering of the motor to regulate the belt tension. Grinding wheels from 12 to 18 inches in diameter can be used on this machine.




Dial on Do-All Contour Machine which Shows Correct Saw Speeds, etc., for Different Materials

Fig. 1. Light Type Grinding Machine Brought out by the Standard Electrical Tool Co.

Fig. 2. Angle-plate Grinder Made in 2 to 10 Horsepower Sizes

The vertical angle-plate grinder made by the concern is now available in sizes from 2 to 10 horsepower. This machine, which is illustrated in Fig. 2, can be applied to planers, boring mills, and other machine tools for finishing large dies, for knife-grinding, and for other operations. It can be supplied with either a horizontal or a vertical feed or with both types of feed.

The motor runs at 3600 revolutions per minute and is equipped with a 6-inch diameter cup-wheel. However, when a larger wheel is required, the larger-size grinders can be supplied with motors operating at 1200 or 1800 revolutions per minute.

## Sheffield Comparator Gage

A comparator gage that uses standard make indicators, as seen in the illustration, has been added to the line of precision checking equipment made by the Sheffield Gage Corporation, E. Third and June Sts., Dayton, Ohio. This comparator retains features of the Sheffield visual gage described in June, 1935, MACHINERY, page 639, but it is lower in price. The gaging head utilizes the patented fine-adjusting sleeve for rapid movement of the dial hand to the final setting for an inspection.

Sheffield Comparator Gage with Dial Indicator

The gaging head is raised and lowered by a handwheel at the right, while a clamping wheel at the left is employed to lock the head at the desired heights. The entire gaging head can be swiveled on the column for use on work located on other surfaces than the self-contained anvil. Special anvils can be supplied. Indicators reading to 0.0001 inch and having a range of either 0.001 or 0.003 inch are being used on the comparator.

## Sterling Light-Weight "Speed-Bloc" Sander

An improved air-driven "Speed-Bloc" sander has been brought out by the Sterling Products Co., 2457 Woodward Ave., Detroit, Mich., which weighs only 5 1/2 pounds. It is identical in appearance with the model described in MACHINERY, April, 1936, page 564, which weighed 2 pounds more. The sander is 7 inches long by 4 3/4 inches high by 3 3/4 inches wide, and is therefore of dimensions that provide a comfortable fit in the hand of the user.

This sander operates on air pressure of from 45 to 60 pounds per square inch, and uses approximately 6 cubic feet of air a minute under load. The cam, flywheel, and connecting-rod are supplied with double-shielded ball bearings. The sander operates at speeds of from 1750 to 3000 complete oscillations a minute, the travel of the sanding pad being 5/8 inch. From one to five abrasive sheets can be attached to the pad. Pads of varying flexibility are available for different surfaces and materials.

## Walker-Turner Flexible-Shaft Grinder

A 1/2-horsepower heavy-duty flexible-shaft grinder designed to occupy minimum floor space is being placed on the market by the Walker-Turner Co., Inc., 1837 Berckman St., Plainfield, N. J. This equipment is provided with a telescopic column that permits the shaft to be adjusted 15 inches vertically. The normal height is 42 inches, and the full height 57 inches.

The flexible shaft is 5 feet 4 1/2 inches long. It is rubber-covered, and is supplied with an S K F ball-bearing hand-piece. The motor swivels on its support, but it can be locked in any position. The deep base serves also as a tool tray. Although this is an inexpensive machine, S K F ball bearings are used throughout, in addition to the hand-piece application.

Flexible-shaft Equipment with Telescopic Column

McCrosky Jack-Lock Milling Cutter Having Blades Tipped with Tungsten Carbide

## McCrosky Jack-Lock Milling Cutters with Tungsten-Carbide Tipped Blades

The Jack-Lock wedge, developed by the McCrosky Tool Corporation, Meadville, Pa., for locking serrated tool blades in a body, has now been adopted in a line of shell end-mills and face milling cutters that have been especially designed by the concern for using tungsten-carbide tipped blades. This type of wedge possesses features that are particularly suitable for tungsten-carbide applications.

The wedge is semicircular in cross-section and occupies a corresponding recess in the cutter body, as may be seen from the illustration. Tightening of the socket set-screw in the wedge lifts the wedge like a jack and forces it over against the blade with a compound wedging action that provides the rigid support and freedom from vibration essential to the proper performance of tungsten carbide. The wedge can be unlocked and locked without hammering when blades must be adjusted.

The cutter body is of a cone type, so designed as to give full support behind each tipped blade and ample clearance in front of the cutting edge. The blades are set at the proper shear and rake angles for tungsten carbide. The serrations are horizontal and parallel to the bottom, so that the blades can be adjusted to compensate for wear either by moving them forward or by stepping from serration to serration.

Behind each blade is an adjustment screw which engages threads in both walls of the blade slot and bears against the back of the blade. It provides a fine forward adjustment and also permits independent adjustment of each blade. Thus a blade with a chipped tip can be reclaimed without sacrificing the tipped material of other blades in the same set.

Jack-Lock shell end-mills with tungsten-carbide blades are available in diameters from 3 to 8 inches, and both medium-duty and heavy-duty face mills in diameters from 7 to 20 inches.

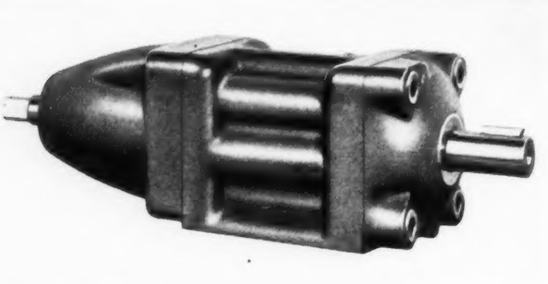
## Chambersburg Press Built for Calibrating Preloaded Bearings

A hydraulic press designed to enable the manufacturers of anti-friction bearings to accurately calibrate preloaded bearings has recently been designed by the Chambersburg Engineering Co., Chambersburg, Pa. This press is of simple design, consisting principally of a frame, a vertically moving platen that is under an accurate pressure control, and a fixed cap which carries a spindle and mechanism for rotating and positioning it. The spindle is driven at 10 revolutions per minute by a 1/4-horsepower motor. It can be raised and lowered by a counterbalanced handwheel, and locked in position when test bearings are in place.

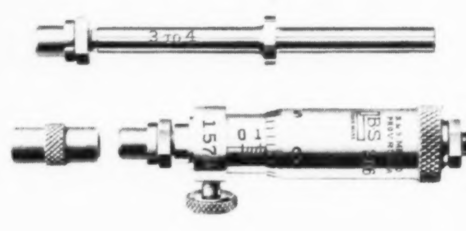
A hydraulic unit at the rear exerts a pressure varying from 100 to 10,000 pounds on the vertically moving table. Pressure is available at any portion of a 14-inch stroke, and any predetermined pressure can be maintained for any desired period of time. The gages on the machine show the amount of pressure applied to the ram, in pounds per square inch, these gages being calibrated after fixtures have been installed on the machine, so that an accurate determination can be made of the total pressures exerted.

The vertical movement of the table is controlled by a handwheel which has four operating positions. These provide a rapid closing stroke, a pressure stroke at reduced speed, a neutral position, and an opening position.

Hydraulic Press for Determining Preloads of Bearings



One-horsepower Unit of a New Line of Sundstrand Fluid Motors





Brown & Sharpe Inside Micrometers with Handy Means of Adjusting for Wear

## Sundstrand Fluid Motors

The Sundstrand Machine Tool Co., 2530 Eleventh St., Rockford, Ill., is announcing a line of fluid motors of the multiple-piston type. The first unit to be brought out has a rating of 1 horsepower at 900 revolutions per minute, and is of compact design, as shown in the illustration. It is intended that larger capacity fluid motors of the same type will be placed in production in the near future.

The 1-horsepower unit is especially designed for high-speed applications, although it is suitable for use at speeds as low as 20 revolutions per minute. It can be reversed instantly while running at speeds as high as 3000 revolutions per minute.

These fluid motors are built with a variable-speed adjustment or for constant-speed service. A complete line of multiple-piston pumps is also being brought out for use with the fluid motors.

## Brown & Sharpe Inside Micrometers

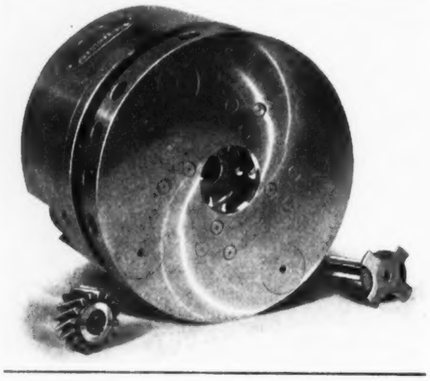
Two inside micrometers, designated Nos. 266 and 267, have recently been added to the products of the Brown & Sharpe Mfg. Co., Providence, R. I. These micrometers measure from 2 to 8 inches and from 2 to 12 inches, respectively, in thousandths of an inch.

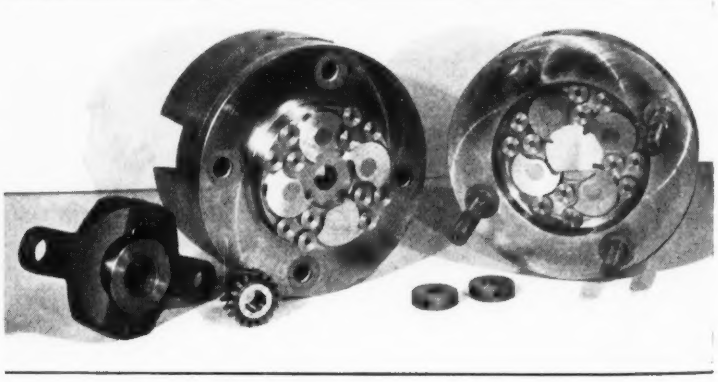
The principal feature is an adjustable point and lock-nut on the thimble, by means of which any wear that may occur can be compensated for by adjusting this one measuring point to a fixed distance that is stamped on the tool. This design obviates the necessity of adjusting all the individual rods. It is a feature that mechanics will appreciate.

## "Match-It" Chucks for External and Internal Gears

Chucks designed for holding spur, helical, and herringbone gears of both external and internal types for diamond-boring, grinding, and other operations before or after heat-treatment are being manufactured by the LeMaire Tool & Mfg. Co., 2657 S. Telegraph Road, Dearborn, Mich., under the trade name "Match-it." A chuck designed for holding helical gears is shown in the illustrations. The basic principle is that the gear is held solely by the finished surfaces of its teeth in such a manner as to permit the machining of all other important surfaces concentric to a high degree of accuracy.

Gripping of the gear is accomplished by imparting a slight motion either in a rotational or axial direction. The gripping





Figs. 1 and 2. "Match-it" Chuck Made by the Le Maire Tool & Mfg. Co. for Accurately Holding Gears by the Teeth in a Grinding Operation

pressure is exerted through the cross-section of the individual teeth, a feature that is particularly important in holding gears of light construction, having a thin wall. The chuck is operated manually with ease, but it can also be readily adapted for operation by means of pneumatic or hydraulic cylinders.

The outer surfaces of these chucks are free from projections, which eliminates any chance of injury to the machine operator. The chucks can be used as rotating or stationary types. Simplicity of construction is another feature. The two halves of the chucks are duplicates of each other, and are bored while assembled together. The gripping members are also duplicates and fit any position.

The only wearing parts are the gripping members, and these can be reset to a new position when worn. They have enough usable surface to permit being reset from ten to forty times before replacement is necessary. The chucks are custom-built to meet requirements.

## Automatic Alternator for Duplex Pumps

In pumping installations there are frequently two pump units, one to carry the load and the other to be held in reserve for peak loads and to insure continuity of service in the event of breakdowns. In such installations, it is customary to alternate the load between the two pump units, so as to distribute wear.

The Allen-Bradley Co., 1331 S. First St., Milwaukee, Wis., has developed a pilot control panel for automatically alternating duplex units of this type. This panel can be used with any standard float switch and motor starters. It automatically switches the float-switch control circuit from one pump starter to the other each time that the unit operates.

The panel can be used for any type of duplex motor application, as, for example, in connection with refrigerating units, fans, and compressors, when alternate operation is desired. The pilot control device may be a pressure switch, vacuum switch, thermostat, or two-wire push-button, instead of the usual float switch.

## Clark Wire-Coil Truck

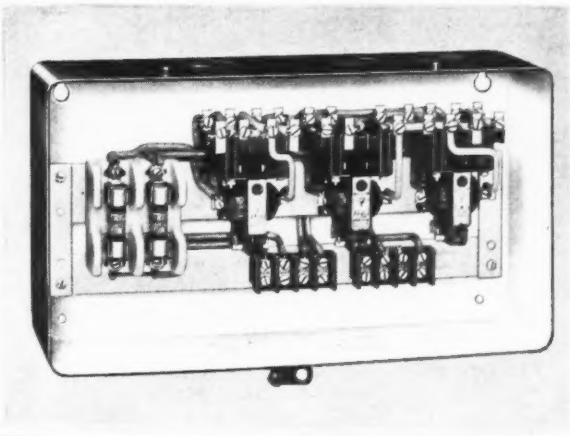
A truck designed especially to facilitate the handling of wire coils has been brought out by the All Steel Welded Truck Corporation, Railroad Ave. and Eighth St., Rockford, Ill. This truck is provided with an end plate that is only 1 3/4 inches above the floor, and the user can therefore roll coils on the truck either from the rear or from the sides. Corrugations on the deck hold the coil in position.

Truck Designed to Facilitate the Handling of Wire Coils

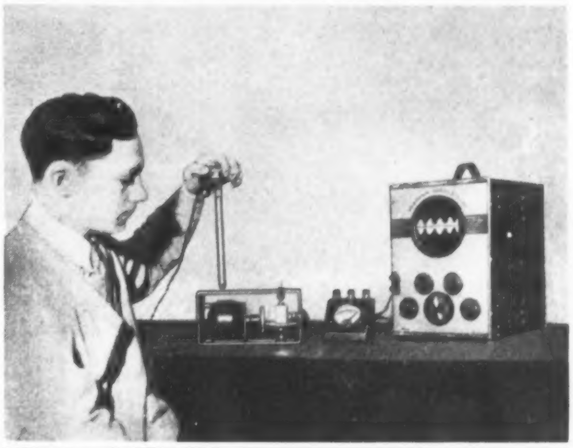
This truck is transported about the shop by means of the Clark "Lift Jack" made by the same concern. The truck has an over-all length of 56 inches, and is 30 inches wide across the wheels. The loading platform is 15 inches wide. The truck weighs 140 pounds, and has a capacity of 2500 pounds. The wheels are 8 inches in diameter, and are equipped with roller bearings.

## Sundt Vibration Detecting Equipment

Vibration detecting equipment so sensitive that it will pick up vibrations from the escapement of a wrist watch, and yet rugged enough to withstand vibrations up to 1/16 inch amplitude, has been placed on the market by the Sundt Engineering Co., 4238 Lincoln Ave., Chicago, Ill. This equipment is known as the



Automatic Alternator for Operating Duplex Pumps, Compressors, and Other Equipment



Equipment for Detecting Vibrations up to 1/16 Inch Amplitude

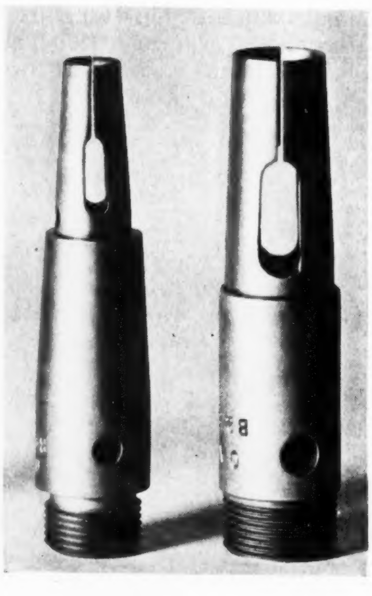
"Model 156 Sunco inertia type crystal vibration pick-up." The bimorph crystal used is mounted inside an aluminum case and has no direct mechanical connection with the 8-inch duralumin test prod. When the case, which weighs only 4 ounces, vibrates, the crystal flexes of its own inertia and sets up voltage impulses.

This "pick-up" is used in connection with a Model 150 Neobeam oscilloscope, which has a built-in amplifier and voltmeter to determine the frequency, amplitude, and velocity of vibration. Small amounts of vibration, as that of watches, can be made audible by means of a loud speaker. The equipment is suitable for the production testing of electric motors, ball bearings, crankshafts, gear trains, fans, and air conditioning apparatus. It is also suitable for use in locating the source of vibration in reciprocating or rotating machinery, in checking the relative smoothness of surfaces, in inspecting longitudinal rods for fracture, and in determining the relative efficiency of materials used for deadening sound.

## Feed-Fingers for Automatic Screw Machines

A line of fingers for feeding stock in automatic screw machines has been developed by the Eastern Machine Screw Corporation, 23-43 Barclay St., New Haven, Conn. These Type K fingers, as they are called, are so designed that the same finger can be used in many different makes and sizes of machines. The fingers are available for round stock from 1/16 inch to 1 1/4 inches in diameter; hexagonal stock from 1/8 inch to 1 1/16 inches; and square stock from 1/8 to 7/8 inch.

The fingers are proportioned to suit the size of the stock to be fed rather than the size of the machine. This insures a uniform gripping pressure. Adapters are provided to fit the different sizes and makes of feed-tubes and to give the proper over-all length of the feed-fingers for each machine. In addition to uniform gripping pressure, the advantages claimed for these fingers are low cost and a simplified inventory. They are designed to reduce bar end wastage to a minimum.

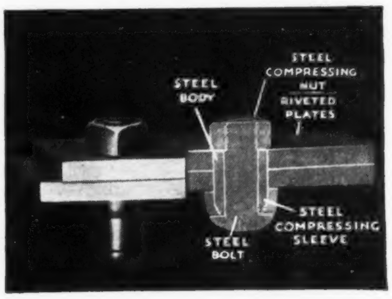


Two H & G Feed-fingers and Adapters

## Multi-Seal "Front-Drive Rivets"

Steel plates and other pieces of work can be assembled together from one side by the use of "Front-Drive Rivets," made by the Multi-Seal Mfg. Corporation, 123 N. Jefferson St., Chicago, Ill. These rivets can be driven at the rate of five a minute by one man. As may be seen from the illustration, they consist of a hardened steel body having horizontal cutting ribs through which a steel bolt is passed; a steel compressing sleeve which is placed on the taper of the body; and a nut on the threaded end of the bolt for locking the assembly together.

These parts are driven as one unit through the prepared hole in the parts to be assembled. Then, when the hexagonal nut is tightened by means of a wrench or nut-runner, the compressing sleeve is drawn down over the bolt shank to form a sealing rivet head on the inner or blind side of the work. Decorative nuts or caps of finished appearance are available for use on the threaded end of the "rivet."




Special Rivet which is Driven from One Side of Work

These rivets are intended for use wherever it is inconvenient to work from both sides of a job, as in the repair or assembly of tanks, pipes, compressors, and various types of machinery.

## Dresser Compression Pipe Fittings

Threaded pipe is not required with the Style 65 pipe fittings being placed on the market by the S. R. Dresser Mfg. Co., 553 Fisher Ave., Bradford, Pa. These fittings are of the design shown in the illustration and come assembled ready for quick application to a pipe line by means of an ordinary wrench.

After inserting plain-end pipes in the fitting from both ends, it is only necessary to tighten the two threaded octagonal follower nuts with a few quick turns of the wrench. As this is done, resilient "armored" gaskets at each end of the fitting are compressed tightly around the pipe to form a positive seal. The resulting joint is permanently tight; absorbs normal vibration, expansion and contraction; and permits deflection of the pipe within the joint. If a pipe is already threaded, it can also be joined with fittings of this type.

The complete line of Style 65 fittings includes standard and extra long couplings, 45- and